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Proceedings of the Pacific Slope Branch of the American Association of Economic Entomologists

Mission Inn, Riverside, California, May 28, 1919

MEMBERS PRESENT

Campbell, R. E., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Day, L. H., County Horticultural Commissioner, Hollister, Cal.
Doane, Prof. R. W., Stanford University, Cal.
Ehrhorn, E. M., Chief Plant Inspector, Honolulu, H. T.
Essig, E. O., University of California, Berkeley, Cal.
Gray, Prof. Geo. P., University of California, Berkeley, Cal.
Larson, A. O., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Ledyard, E. M., U. S. Smelter Co., Salt Lake City, Utah.
Mackie, D. B., California State Commission of Horticulture, Los Angeles, Cal.
Morris, E. L., County Horticultural Commissioner, Santa Ana, Cal.
Neuls, J. D., Braun Corporation, Los Angeles, Cal.
Penny, Donald, County Horticultural Commissioner, Watsonville, Cal.
Quayle, Prof. H. J., Citrus Experiment Station, Riverside, Cal.
Ryan, H. J., County Horticultural Commissioner, Los Angeles, Cal.
Smith, H. S., State Commission of Horticulture, Sacramento, Cal.
Stahl, C. F., Bureau of Entomology, U. S. Dept. Agric., Riverside, Cal.
Taylor, Prof. E. P., University of Arizona, Tucson, Ariz.
Urbhans, D. T., Bureau of Entomology, U. S. Dept. Agric., Berkeley, Cal.
Volck, W. H., California Spray Chemical Co., Watsonville, Cal.
Weldon, Geo. P., California State Commission of Horticulture, Sacramento, Cal.
Woglum, R. S., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Woodworth, H. E., County Horticultural Commissioner, San Mateo, Cal.

VISITING MEMBER

Marlatt, Dr. C. L., Federal Horticultural Board, Washington, D. C.

VISITORS

Armitage, H. M., State Commission of Horticulture, Alhambra, Cal.
Borden, A. D., Bureau of Entomology, U. S. Dept. Agric., Upland, Cal.
Bremner, O. E., County Horticultural Commissioner, Santa Rosa, Cal.
Brock, A. A., County Horticultural Commissioner, Santa Paula, Cal.
Carsner, Eubanks, Riverside, Cal.
Fawcett, Prof. H. S., Citrus Experiment Station, Riverside, Cal.
Gillis, H., Perth Amboy, N. J.
Gorton, G. R., County Horticultural Commissioner, San Diego, Cal.
Hadley, W. B., Horticultural Inspector, Redlands, Cal.
Houpt, L. O., County Horticultural Commissioner, Hanford, Cal.
Hurst, A. E., Covina, Cal.
Hurst, C. J., Covina, Cal.
Knight, Hugh, Citrus Experiment Station, Riverside, Cal.
Koller, J. M., Puente, Cal.
List, Geo. M., Chief Deputy State Entomologist, Fort Collins, Colo.
Mills, Earle, County Horticultural Commissioner, Oroville, Cal.
Newman, C. V., Limoneira Co., Santa Paula, Cal.
Roullard, Fred P., County Horticultural Commissioner, Fresno, Cal.
Rounds, M. B., Bureau of Entomology, U. S. Dept. Agric., Alhambra, Cal.
Strausz, A. L., State Horticulturist of Montana, Missoula, Mont.
Taylor, A. S., Redlands, Cal.
Taylor, F. H., County Horticultural Commissioner, Susanville, Cal.
Turner, C. F., County Horticultural Commissioner, Auburn, Cal.
Waite, F. W., County Horticultural Commissioner, El Centro, Cal.

BUSINESS SESSION

The business session of the Pacific Slope Branch of the American Association of Economic Entomologists was called to order in the Mission Inn, Riverside, California, at 4 o'clock p. m. by Chairman H. J. Quayle who announced the following committees:

Nominating Committee:

R. S. Woglum, Chairman
Geo. P. Gray
R. E. Campbell

Auditing Committee:

T. D. Urbhans, Chairman

Membership Committee:

H. E. Burke, 1 year
H. S. Smith, 2 years
R. W. Doane, 3 years

CHAIRMAN QUAYLE: A ten minute recess will be taken to permit the committees to formulate reports. (Adjournment for 10 minutes.)

CHAIRMAN QUAYLE: We will now hear the report of the Secretary-Treasurer.

E. O. ESSIG: Due to the absence of the Secretary at the last meeting no report was made, so that the following report is for the years 1917, 1918 and part of 1919:

PACIFIC SLOPE BRANCH AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Financial Statement, 1917–1919

1917			
Jan. 1.	On hand		$23.91
Feb. 5.	Affiliation fee to A. A. A. Sci.	$5.00	
Apr. 2.	Large envelopes	.80	
	Multigraphing letters	1.25	
	Printing membership blanks	2.75	
18.	Express on proceedings to A. F. Burgess	.66	
May 1.	Refund from A. F. Burgess for disbursements		9.80
		$10.46	$33.71
	Balance		$23.25
1918			
Jan. 1.	On hand		$23.25
	Interest from Savings Bank		.69
Feb. 21.	Stamps, 1¢	$ .75	
	75 stamped envelopes, 2¢	1.61	
25.	50 stamped envelopes, 2¢	1.08	
	50 stamps, 1¢	.50	
May 2.	Express on proceedings to Dr. E. P. Felt	.57	
		$4.51	$23.94
	Balance		$19.43
1919			
Jan. 1.	On hand		$19.43
9.	100 stamped envelopes, 3¢	$3.14	
Feb. 4.	100 stamps, 1¢	1.00	
14.	100 stamped envelopes, 3¢	3.14	
12.	Affiliation fees, A. A. A. Sci. 1918	5.00	
	1919	5.00	
		$17.28	$19.43
	Balance		$2.15
Feb. 24.	On hand		$2.15
24.	Refund from A. F. Burgess to cover above expenditures		22.45
	Total amount on hand		$24.60

Respectfully submitted,

E. O. ESSIG,
Secretary and Treasurer.

CHAIRMAN QUAYLE: We will now hear the report of the Nominating Committee.

R. S. WOGLUM: Gentlemen, the Nominating Committee present the following names for officers for the ensuing year for the Pacific Slope Branch of the American Association of Economic Entomologists:

Chairman—E. M. Ehrhorn, Honolulu, H. T.

Vice-Chairman—R. W. Doane, Stanford University, Cal.

Secretary-Treasurer—E. O. Essig, Oxnard, Cal.

CHAIRMAN H. J. QUAYLE: I will now instruct the Secretary to cast the ballot electing the officers proposed by the Nominating Committee.

(Ballot cast by the Secretary.)

CHAIRMAN H. J. QUAYLE: Is there any further business to come before this meeting? If not I declare the meeting adjourned to meet the with Pacific Division of the American Association for the Advancement of Sciences wherever the latter association decides to meet during the year 1920.

PROCEEDINGS

The fourth regular annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at the Mission Inn, Riverside, California, in connection with and as a part of the State Fruit Growers' Convention.

The meeting was called to order at 10 o'clock a. m. by the Chairman, Prof. H. J. Quayle.

As the Secretary had not yet arrived, Mr. Roy E. Campbell was elected Secretary *pro tem.*

CHAIRMAN H. J. QUAYLE opened the meeting with a few informal remarks and a welcome to all present. He suggested a closer coördination of the endeavors of Western entomological workers, specially urging coöperation in the selection and working out of problems of importance in order to eliminate duplication of effort in so far as such a plan was possible and practical. He then called upon several of those present to say a few words.

Those who were called were Dr. C. L. Marlatt, who brought a hearty word of welcome from the Entomological Society of Washington.

MR. E. M. EHRHORN briefly described the introduction of parasites into the Hawaiian Islands and told of the plant inspection service and new equipment for such work at Honolulu.

MR. G. M. LIST spoke of the work being done in Colorado and brought greetings from the entomologists there who were unable to attend the meeting.

CHAIRMAN QUAYLE: The first paper on the program is entitled "A Suggestion of a Possible Control of Pea and Bean Weevils," by Mr. Roy E. Campbell, of the U. S. Bureau of Entomology, Alhambra, California.

A SUGGESTION OF A POSSIBLE CONTROL OF PEA AND BEAN WEEVILS

By ROY E. CAMPBELL, *U. S. Bureau of Entomology, Alhambra, Cal.*

During the past several years, the writer has been making an investigation of the broad or horse bean weevil [*Laria* (*Bruchus*) *rufimana*][1] in California, and has observed an example of very good control or prevention of infestation by regulating the time of planting the seed. The opportunity is now taken to make a note of the observations with

[1] There seems to be some doubt about the proper name of this species. Dr. W. D. Pierce gives the generic name Mylabris Geoffroy precedence over Laria Scopoli and Bruchus Linneaus, while Dr. F. H. Chittenden favors the genus Laria.

the suggestion that the same methods might be applicable to the pea weevil [*Laria* (*Bruchus*) *pisorum*], and possibly to the several bean weevils. Dr. F. H. Chittenden is inclined to the belief that in some localities, such as Washington, D. C., where two crops of peas can be grown each year, late planting will result in sound seed stock, but according to available information, this is the first time the matter has been definitely followed for several seasons, and by a large number of observations and experiments the theory of late planting definitely proved.

The broad bean weevil is found in California wherever broad or horse beans are grown, but the principal districts are around San Francisco Bay, and down the coast to a little below San Luis Obispo. Alameda County formerly was the most extensive producing section, but due largely to heavy weevil infestation of practically all beans grown there, it is now of no commercial importance as a horse bean section. The following table, showing the infestation of broad beans from the Oceano-Morro and Sacramento districts, from numerous samples taken and tested by pure food inspectors of the Bureau of Chemistry,[1] and by the writer, is typical of all other districts.

TABLE I. SUMMARY OF THE 1916, 1917 AND 1918 CROP OF BROAD BEANS FROM THE OCEANO-MORRO AND SACRAMENTO DISTRICTS

District		1916 Per cent of infestation	1917 Per cent of infestation	1918 Per cent of infestation
Sacramento	Max.	41	63	84.3
	Min.	0	0	1
	Av.	9.09	12.7	22.4
Oceano-Morro	Max.	50	63	17.2
	Min.	0	0	0
	Av.	14.5	14.5	2.92

Sacramento is the newest horse bean section, and a glance at the table will show that not only the maximum per cent of weevil infestation of beans produced there, but also the average, increased each year. The low percentage for the Oceano-Morro sections for 1918 will be explained later.

LIFE HISTORY

The eggs are laid on the surface of the green bean pods in the field. No eggs were observed by the writer except on the pods, the latter varying in size from less than an inch to over five inches. Most of the eggs are laid on the larger pods.

[1] The writer is indebted to the Western Division of the Bureau of Chemistry, and Mr. M. A. Rex, pure food inspector, for supplying all the data they had collected on the horse bean crop of California for the last four years.

The eggs hatch in from 9 to 18 days, the young larvæ boring directly into the pod, and from thence into the nearest bean, in which they feed during the remainder of the larval life. The duration of the latter is from 10 to 15 weeks. Pupation takes place within the bean, in the cell eaten out by the larva, and requires from 7 to 16 days.

The adult may emerge from the bean immediately, or remain within it for several months. The length of the adult life is from 1 to 8 months.

Seasonal History

While the first eggs are laid soon after the middle of March, and a few may be laid as late as the middle of May, the most extensive deposition occurs during the month of April. Larvæ may be found from the latter part of March to the middle of October; pupæ from the first of August to the latter part of October, and adults from the middle of August to the following June.

Although a few adults live until June, by far the greater number die off several months sooner. In storage 90 per cent of the weevils are dead by the first of April. Field observations at Hayward showed that the first active weevils were observed in broad bean fields on March 25, that the number increased until May 4, after which it decreased constantly until June 15, the last date any live adults were observed in the field.

Cultural Methods of Control

Time of Planting

The planting season for horse beans begins soon after the first fall rains, usually in October or November, and continues until late spring. Horse bean buyers and growers have noticed for some time that beans from seed planted early in the season usually have a higher percentage of weevil infestation than beans from seed planted later. This was checked up by making a table from the data collected by the Bureau of Chemistry, whose inspectors, when taking samples of horse beans, ascertained as far as possible when the seed had been planted. About 20,000 sacks from seed planted early, that is before January 1, in 1916 and 1917, gave an average of slightly over 33 per cent of the beans infested, while about 7,500 sacks from seed planted late, or after March 1, averaged 6.4 per cent weevil infested.

From numerous samples taken of crops planted in certain months in the three seasons, 1916 to 1918 inclusive, the following averages were obtained:

TABLE II. COMPARISON OF THE PER CENT OF WEEVIL INFESTATION OF HORSE BEANS PLANTED IN DIFFERENT MONTHS. FIGURES ARE AVERAGES FOR THE THREE YEARS, 1916, 1917 AND 1918

Month Planted	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Per cent infested	46	42.3	16.6	16.7	9.7	11.5	2.6	.4

This was further tested by experimental plantings at Alhambra and Hayward during the season of 1917 and 1918, with the following results:

TABLE III. AVERAGES OF THE PER CENT OF WEEVIL INFESTATION IN EXPERIMENTAL PLANTINGS AT ALHAMBRA AND HAYWARD, DURING 1917 AND 1918

Month Planted	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Per cent infested.....	53.8	34.9	14.9	11	5.4	4	3.5

It is plainly evident from these tables that the percentage of infestation is very much less in crops from seed planted late in the season than from crops which were planted early. The life history of the insect suggests an explanation of this. It was observed that egg deposition began about March 15, was heaviest in April and ended by the middle of May. It seems reasonable to believe that pods produced before or during April will be exposed to the greatest egg laying, but pods produced after the latter part of April will be subject to little or no egg deposition.

Further evidence on this point is furnished by horse bean growers of San Luis Obispo County. It had been the custom there, as elsewhere, to begin planting in October or November and continue until May. But because of severe infestation of the bean aphis (*Aphis rumicis* L.) on the early planted horse beans for several years, and on the contention that horse beans acted as a winter host for this pest, propagating it in great numbers, the County Horticultural Commissioner persuaded the growers not to plant any horse beans until after March 1, in the 1918 season. The result is shown in Table I, with a maximum of 50 and 63 per cent of weevil infestation, and averages of 14.5 per cent for the 1916 and 1917 crops when the seed was planted both early and late, as contrasted with a maximum of only 17.2 per cent and an average of 2.92 per cent of weevil infestation for the 1918 crop, when no seed was planted until after March 1. Many samples of this season's crop were entirely free from infestation, particularly those from seed planted in April and May.

When the first observations were made on the effect of late planting, it was suggested that with an abundance of pods available on which to

oviposit, the females became spent early in the season, which resulted in little or no infestation of beans produced late, but if there were no pods in the early part of the season, the females would merely hold over until pods were available. The above data definitely shows this suggestion not to be the case, because although there were few or no horse bean pods in San Luis Obispo County during the regular egg laying season of 1918, the females were quite apparently unable to hold over and deposit eggs on the later produced pods.

Therefore, from the figures given in the tables and the experience of San Luis Obispo County, the efficiency of late planting as a control for the horse bean weevil is definitely proved. It should be noted, in passing, that late planting can only be practised where there is an abundance of soil moisture, or plenty of water for irrigation, and in localities where the spring weather is not too hot or dry.

Since the pea weevil has a very similar life history, will not such methods also apply to it?

CHAIRMAN QUAYLE: The next paper will be presented by Mr. Harry S. Smith, Superintendent of the State Insectary of the State Commission of Horticulture, Sacramento, California. He will speak "On Some Phases of Insect Control by the Biological Method."

ON SOME PHASES OF INSECT CONTROL BY THE BIOLOGICAL METHOD[1]

By HARRY S. SMITH, *California State Commission of Horticulture, Sacramento, California*

The biological method of insect pest control, broadly speaking, embraces the use of all natural organic checks, bacterial and fungous diseases as well as parasitic and predaceous insects. The remarks in this paper, however, refer to the use of entomophagous insects only, since the writer has not had an opportunity to make observations on the diseases on insects, and conditions in California do not seem in general to favor their use as means of pest control.

From a practical standpoint the biological method may be arbitrarily divided into two sections: *First*, is the introduction of new entomophagous insects which do not occur in the infested region; and *second*, the increasing, by artificial manipulation, of the individuals of a species already present in the infested region, in such a way as to bring about a higher mortality in their host than would

[1] Occasional contributions from the California State Insectary, No. VI.

have occurred if left to act under normal conditions. The *first* embraces only the establishment of a species in the local fauna, while the *second* involves an attempt to make the entomophagous insects continually dominate their host, a condition which cannot prevail if nature is left to act unaided.

So far as the first section of biological control is concerned, entomologists are, it is believed, pretty well agreed that the introduction of as many new beneficial insects as may be obtained is desirable, provided only that the work is done with an intelligent understanding of the interrelations of entomophagous insects. Dr. L. O. Howard states that " . . . since there exist all over the world beneficial insects, many of which can undoubtedly be acclimatized here, and some of which will undoubtedly prove of value to American agriculture, carefully planned work should be begun looking to the ultimate increase of our insect population by the addition of as many of the beneficial forms as possible." It is hardly necessary to add that such introductions should be made with a proper appreciation of the possible results to be obtained and, because of its retarding effect on the use of other means of control, over-optimistic and premature advertising should be carefully avoided.

The other section or type of work with entomophagous insects, that embracing the artificial manipulation of species already established in the infested area in such a way as to increase greatly their numbers and thus to decrease the numbers of their host, has not been looked upon with equally great favor by entomologists.

Biological control by this latter method is based on the proposition that fluctuation in abundance of host and parasites may be prevented and the host insect kept permanently in subjugation, by maintaining a super-abundance of natural enemies in the orchard or field at all times. The "balance of nature" is like a pendulum, swinging to and fro, the dominance of any species alternating with that of its natural checks. The method of control here under consideration is based on the assumption that by artificial manipulation the natural checks can be made to permanently dominate the species against which they exert a controlling influence. There may exist a perfect "balance" in the relation between a species and its host and the host still be a pest because the number of individuals occurring at the time of greatest abundance is sufficient to damage cultivated crops. It is a well-known fact that in the relation between host-insect and its natural checks there is a point where the natural enemies, having temporarily dominated the host, themselves become almost extinct, with the result that the remaining individuals of the host are again permitted to breed almost without hindrance. This is the strong vantage-point

in attack by the biological method because if we can liberate a surplus of natural enemies of the pest when they are normally at low ebb, the host also being scarce we should be able to prevent the host insect from gaining that ascendency which makes it sooner or later a pest. Under these conditions many of the natural enemies would, of course, die from starvation and the premises would have to be restocked from time to time.

From a biological standpoint the proposition seems a sound one, but what entomologists and agriculturists want to know is whether or not it can be put into practice. The writer believes that there are fundamental principles involved in this work which in the case of certain pests would so limit the possibilities that an attempt to apply it to field conditions would not be justifiable, while in the case of other pests, or under other conditions, the opposite would be true. In other words, a decision as to its applicability in the control of any pest should be arrived at only after a careful study of each individual case with reference to the limiting factors.

Among the factors which govern the possibilities in this direction the following are important:

1. Comparative Reproductive Capacity of Host and Available Entomophagous Insects. This is obviously of much importance. If the host insect breeds with great rapidity and the only available entomophagous insects are of low reproductive capacity, success in the attempt could hardly be expected.

2. Power of Locomotion of Pest and Natural Enemies. As a general rule attempts to control an insect pest by the biological method will be undertaken locally, and not over the entire range of the insect. If the pest is an active flier, its ability to continually and quickly reinfest the area where the attempt is being made would react unfavorably on the effort. If the entomophagous insects are active fliers it is possible that their tendency to disperse rapidly from the place of liberation may also work against the success of the undertaking.

3. Sequence of Available Entomophagous Insects. It is very desirable, especially where use is being made of parasitic rather than predaceous insects, that there be a complete sequence of parasites affecting the egg, larva and pupa of the pest. This is for the reason that multiple parasitism, or parasitism by two or more different species in the same individual of the host insect, at times reduces the efficiency of the parasites as a whole. The ideal arrangement would be a single efficient parasite for each of the three stages of the host, but this is not a necessity, especially if predaceous insects are also employed.

4. Possibility of Rearing or Obtaining the Entomophagous Insects in Sufficient Quantities. This is one of the most impor-

tant factors, and probably is the one which will, more often than any of the others, work against the success of such undertakings. Unless the beneficial insects can be either reared or collected in great numbers success will not be possible. In cases where the entomophagous insect takes readily to rearing in confinement, the possibility of rearing or obtaining a host insect in quantity is what limits the undertaking. This is in turn limited by the availability of a host plant upon which to grow the host-insect. In any event the beneficial insects must be had in sufficiently large quantities that they will be enabled to overcome the pest in the field.

5. Cost of Producing Natural Enemies in Comparison with Value of Crop and with Artificial Control, if any. The factor of cost of production is, of course, one of the most important, since the main objective sought in biological control is economy. The cost should not even closely approach that of effective artificial control if such exists. In the case of the mealy-bugs, where there is no very satisfactory artificial control known, the cost factor is not of such very great importance, yet it obviously must remain well within the bounds of profitable crop production.

6. Presence of Secondary Parasites in the Local Fauna. The retarding effect of the existence in the local fauna of secondary parasites that will strongly attack those with which the work is being carried on, must be taken into consideration. Undoubtedly it will in some cases be sufficient to render the work unsuccessful, because if by artificial manipulation a superabundance of natural enemies of the pest is created, conditions will then be ideal for the secondary parasites. In most cases it will be practically impossible to foresee just what would occur in cases of this kind and a practical attempt would have to be made in order to ascertain just what part the secondary parasites, and the primary parasites of the predaceous insects, would play. Undoubtedly this factor will limit, or entirely prevent, the control of many of our insect pests by this method.

7. Unfavorable Agricultural Practice. Under conditions where certain agricultural practices are essential, these will in some cases perhaps make efforts at biological control inadvisable. For example, if an orchard is infested with two or more insect pests, one of which can be controlled by the biological method and the other cannot be, the latter requiring artificial treatment such as fumigation or spraying, such practices, affecting adversely the breeding of natural enemies, would make it impractical to attempt to apply the biological method as a control for the other pest.

These are, it is believed, the most important factors which must be taken into consideration, in contemplation of any project on the

biological control of insect pests. There are, of course, many others of lesser importance, such as the occurrence of ants in scale-infested orchards, cases where the pest exists on a short-lived crop, etc., but time will not permit of their being mentioned, nor the discussion of the others in detail. This brief outline will perhaps, however, give some idea of the several factors which will influence, either favorably or unfavorably, attempts to put the biological method into practice.

This type of pest control has already been put to practical use in a limited way in California, and has proven to be a complete success. The citrus mealy-bug, which has been one of the most difficult to control of all the citrus pests, has been brought into complete subjection in several orchards in southern California, through the continued liberation of large numbers of entomophagous insects, principally *Cryptolaemus montrouzieri*. These were in part reared by the State Insectary, by the use of the potato sprout method developed by the writer, and in part collected in orchards where they had become abundant late in the season. One cannot, of course, conclude from this that the method will prove equally successful against other pests, but it does indicate that, where conditions are favorable, results may be obtained which will go far toward bringing about economy in pest control.

The discussion of this paper was led by Mr. R. S. Woglum and J. D. Neuls.

CHAIRMAN H. J. QUAYLE: The next paper entitled "Observations on Some Mealy-Bugs" will be read by the Secretary in the absence of the author Mr. G. F. Ferris:

OBSERVATIONS ON SOME MEALY-BUGS (HEMIPTERA; COCCIDAE)

By G. F. FERRIS, *Stanford University, Cal.*

The following notes have to do for the most part with certain species which are already of economic importance or may be regarded as awaiting only a favorable opportunity to become so.

1. The proper name of the "Citrophilus" mealy-bug. Unfortunately the name, *Pseudococcus citrophilus*, given by Claussen to this pernicious species cannot stand, for the species had been described only a few months before by Mr. E. E. Green[1] as *Pseudococcus gahani*, from specimens taken from *Ribes sanguinea* in London, England.

[1] Green, E. E., Ent. Mon. Mag., 51: 179; pl. 16, figs. 4–5. (May, 1915.)

Suspecting, from the description and figures given by Green, that the two were identical I forwarded specimens to him for comparison. He informs me that the two are undoubtedly the same. This record is a matter of some interest as the species had not before been recorded outside of California. Here it is without much doubt an introduced species and as its original home is unknown all records of its occurrence in other lands are of importance as affording possible clues to its origin. However, I am inclined to think that it is an alien in England as well as here, for it seems doubtful that such a species would so long have remained unnoticed.

The necessity of changing a name as well known as this affords a strong argument against the practice of adopting the scientific name of a species as its common name also. It may as well be recognized that in this group especially stability in nomenclature will certainly not be arrived at for many years to come. This is an unfortunate condition but it may be greatly ameliorated by the adoption of well chosen vernacular names. It is also to be taken as evidence of the necessity of studying the scale insects from collections representing the widest possible geographical range and not from merely local faunas.

2. *Pseudococcus maritimus* (Ehrh.) in England and Florida. From Mr. E. E. Green I have received for determination specimens of a mealy-bug which he informs me occurs on various plants in green-houses in England. This is certainly *P. maritimus* (Ehrh.) (=*P. bakeri* Essig), which has not before been recorded from any point outside of the United States.

From Mr. J. Chaffin of the State Plant Board of Florida I have received this same species, from sweet potato, tomato and avocado on the Dry Tortugas Islands near Key West. It has not before been recorded from this portion of the United States.

3. *Pseudococcus pini* (Kuwana) in California. From Mr. H. S. Smith I have received specimens of this species from pine in a Japanese nursery at Oakland. It was originally described from Japan and has not previously been reported from this country, although Mr. Ehrhorn informs me that he has seen what was probably this species on pines in a nursery at San Jose. I append a redescription of the species.

4. *Pseudococcus bromeliae* (Bouché) in Florida. This species appears regularly in the "Reports of Pests Intercepted" by the various quarantine offices but, as far as I am aware, has not been recorded as established in the United States. From Mr. Chaffin I have received specimens from roots of banana at Florence Villa, pineapple at Frost Proof and citrus at Ft. Meyers, Florida. The existing descriptions are quite inadequate and I append a redescription.

5. *Pseudoccocus virgatus* (Ckll.) in Florida. This widely distributed

tropical species appears to have been recorded but once from the United States, from "cactus and other plants" at Brownsville, Texas. From Mr. J. Chaffin and Mr. C. J. Drake I have received specimens taken from Magnolia and mulberry at Gainesville, Oleander at Key West and "undetermined weed" at Winter Haven, Florida. I append a redescription of this species also.

6. *Pseudococcus comstocki* (Kuwana), a dangerous mealy-bug. *Pseudococcus comstocki* (Kuwana) was originally described from specimens taken from mulberry and maple in Japan. In a sending of mealy-bugs recently received from Mr. Kuwana there were included specimens of this species from a long series of hosts, including the following: *Castanea*, cherry, citrus, *Eleagnus*, *Euonymus*, *Kraunhia*, melon, persimmon and peach. What is unmistakably the same species occurs in the eastern part of the United States, Professor Doane having taken specimens from apple, horsechestnut, *Hydrangea*, maple, mulberry, wild cherry and some other hosts on Staten Island, New York. Professor Doane informs me that in this locality the species is a serious pest and that some of the mulberry trees have been much injured by it. I have received the same species from various hosts in Maryland, also.

From the facts recited above it is obvious that this species is a worthy candidate for admission to that select fraternity which includes *Pseudococcus citri, gahani, longispinus* and *maritimus*. Its introduction into California is certainly to be feared.

There occurs on the Monterey pines on the Campus of Stanford University a mealy-bug that I have not been able to separate from *P. comstocki*. However, the behavior of these local representatives is beyond reproach. They appear to be confined to the pines; they are relatively few; they are heavily parasitized; there are apparently but one or two generations per year. It is probable that this represents a monophagous strain or race of this species and that its spread to other hosts is not to be feared.

I have described this species in an earlier paper dealing with the California species of mealy-bugs and shall not consider it further here.

The Mealy-Bug at Ojai

From Mr. H. S. Smith and from Mr. E. O. Essig I have received specimens of a mealy-bug taken from citrus at Ojai. In regard to the identity of this species there is unquestionably room for argument. Basing my opinion entirely upon slide mounts I have said that while the species is undoubtedly very close to *P. citri* it is apparently distinct and that of the species known to me it most closely approaches *P. kraunhiæ* (Kuwana) from Japan. Extreme examples are easily

separable from *citri* but it must be admitted that some examples are not. The form may be merely an extreme variant of *citri* or it may be a race or strain—call it what you please.

Mr. Smith and Mr. Armitage inform me that from field observations they are convinced that this is not *citri* and Mr. Woglum states that from a superficial examination only he too is inclined to agree with this viewpoint. I have previously noted the species in my paper on the California mealy-bugs but in view of its possible importance and its close resemblance to *citri* more extended studies are desirable, the description which I have given needing to be amplified. I shall not here attempt such a study.

Descriptions of Species

Pseudococcus pini (Kuwana)

Fig. 15. *Pseudococcus pini* (Kuwana): left, anal lobe and penultimate cerarii; right, ventral side of anal lobe.

Habit. The original description of this species contains but little information concerning its appearance in life, nor, from the material that I have examined can I add anything. Judging from the morphology of the species, however, it will have much the appearance of *P. citri*, but the marginal tassels will not be present anterior to the abdomen. The species probably does not secrete a large ovisac. Body contents reddish.

Morphological Characteristics. With but five or six pairs of cerarii, these on the last five or six segments of the abdomen. Each cerarius with two rather slender, conical spines, with a very few pores and without auxiliary setæ except for a few about the anal lobe pair. Spines of the anal lobe cerarii largest, the others becoming progressively smaller anteriorly. Ventral side of the anal lobes normally with a small but well defined, chitinized bar extending in from the base of the minor seta. There is some variation in this character and in some specimens it appears not to be developed. Spines of the dorsum rather few and small, their bases rather stout, their tips tending to be somewhat flagellate, those of the head longer and more slender than the others. Ventral setæ longer and more slender than those of the dorsum.

Tubular ducts apparently few, all small and without a raised rim about the mouth, not at all concentrated near the lateral margins of the abdominal segments. Legs and antennæ presenting no distinctive characters. Anal lobe and anal ring setæ approximately equal, two or three times as long as the diameter of the anal ring.

MATERIAL EXAMINED. Specimens from the type material; from pine, Kiushiu, Japan; from *Pinus thunbergii*, Yokohama, Japan; from pine in a Japanese nursery at Oakland, California.

NOTES. This species very closely resembles another that I take to be *P. azaleæ* (Tins.), of which I have specimens from numerous hosts in Japan. The two differ chiefly in the fact that in the latter species the tubular ducts are very numerous and are concentrated near the lateral margins of the abdominal segments and also in the fact that in this species the derm of the adult tends to be of a bluish color and the body contents black.

Pseudococcus bromeliæ (Bouché)

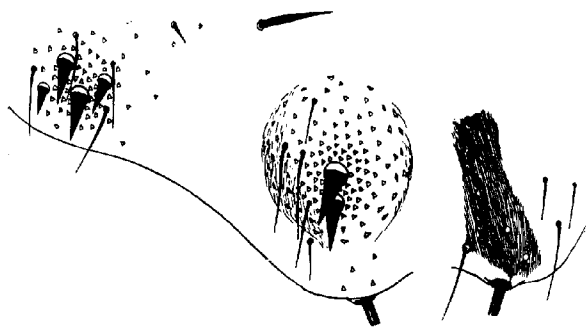


Fig. 16. *Pseudococcus bromeliæ* (Bouché): left, penultimate and anal lobe cerarii; right, ventral side of anal lobe; above a disproportionately enlarged dorsal spine.

HABIT. The existing descriptions of the species are not especially definite in regard to the appearance of the species in life and I can add but little.' The marginal tassels are quite long, the caudal pair being but little longer than the others. Apparently the species does not form an ovisac.

MORPHOLOGICAL CHARACTERISTICS. With seventeen pairs of cerarii, all with auxiliary setæ, with numerous pores and in part with three or more cerarian spines. There is some variation in regard to the number of cerarian spines but in general the arrangement is as follows. Anal lobe pair always with but two; four or five pairs anterior to these and the first three on the head normally with three or four spines; remainder normally with but two. The spines of the anal lobe pair are largest. No chitinized areas about any of the cerarii, except sometimes a faintly indicated area

about those of the anal lobes. Ventral side of the anal lobes with a quite large chitinized area extending in from the base of the anal lobe setæ. Dorsal body setæ rather few, small, stiff. Ventral setæ likewise few, slender, longer than those of the dorsum. Tubular ducts for the most part confined to the venter, all small and without a raised rim about the mouth. Anal ring of ordinary character. Anal lobe and anal ring setæ about equal, about one and one-half times as long as the diameter of the anal ring. Antennæ and legs presenting no unusual characters.

MATERIAL EXAMINED. From pineapples at quarantine from Hawaii and West Indies; from roots of banana at Florence Villa; pineapple at Frost Proof and citrus at Ft. Meyers, Florida.

Pseudococcus virgatus (Ckll.)

Fig. 17. *Pseudococcus virgatus* (Ckll.): dorsal aspect of anal lobe and portion of penultimate segment.

HABIT. A rather slender form, attaining a length of 4.5 mm. Thinly dusted with powdery secretion, with a pair of longitudinal submedian dark stripes. Caudal tassels attaining about half the length of the body, lateral tassels lacking. Dorsum bearing numerous delicate, glassy, waxen threads which arise from near the margins. Viviparous.

MORPHOLOGICAL CHARACTERISTICS. With but a single pair of cerarii, these on the rather prominent anal lobes, each with two (or sometimes three) quite large cerarian spines, numerous, but scattered, pores and a few slender setæ. The cerarii are not surrounded by a chitinized area. Ventral side of the anal lobes sometimes with a very small, chitinized area, which is normally lacking. The most conspicuous feature of the species is the presence of numerous, unusually large ducts, the mouths of which are surrounded by a small, chitinized area which bears from one to four small setæ. It is from these ducts that the glassy threads, which are so conspicuous in the living insect, arise. The arrangement of these ducts is fairly definite. Except for a

median pair on three or four abdominal segments and an occasional duct on the dorsum of the thorax they are confined to the lateral margins, there being normally six or seven at each lateral margin of the penultimate segment and two or three at each lateral margin of the other abdominal segments (except the last) and the thoracic segments also, together with an indefinite number on the head. Dorsal body setæ relatively few, small and slender. Ventral setæ much longer. Anal ring noticeably large, rather weakly developed. Anal ring setæ about twice as long as the diameter of the anal ring and slightly shorter than the anal lobe setæ. Antennæ and legs rather slender, the antennæ eight-segmented, the claw without a tooth.

MATERIAL EXAMINED. From various hosts in Hawaii, Philippine Islands and Nicaragua and from the following hosts and localities in Florida; mulberry and *Magnolia* at Gainesville; undetermined weed at Winter Haven; *Oleander* at Key West.

NOTES. This is far from being a typical *Pseudococcus*. In the nature of the ducts it resembles *Phenacoccus stachyos* Ehrh., but the latter has nine-segmented antennæ, eighteen pairs of cerarii and a tooth on the claw.

SYNONYMY OF SOME COCCIDÆ

Pseudococcus quercus (Ehrh.)

1900. *Dactylopius quercus* Ehrh., Can. Ent., **32**: 220. (Part.)
1910. *Pseudococcus agrifoliæ* Essig; Essig, Pomona Col. Jn. Ent., **2**: 147–148, figs. 60B, 60C. (Misidentification.)
1918. *Pseudococcus quercicolus* Ferris, Calif. Species Mealy-Bugs, Stanford Univ. Publ., p. 50, pl. 2, f. 18.

Through the kindness of Mr. Ehrhorn I have been enabled to examine the type slide of *Pseudococcus quercus*. The slide contains two specimens, of which one is *P. crawii* (Coq.) and the other *P. quercicolus* Ferris. This being the case the name *quercus*, which I have previously placed as a synonym of *crawii* may be revived for *P. quercicolus*.

Lachnodius phoradendri(Ckll.)

1912. *Pseudococcus phoradendri* Ckll., Jn. N. Y. Ent. Soc., **20**: 133.
1919. *Lachnodius salicis* Ferris, Contrib. Knowl. Coccidæ Sw. U. S., Stanford Univ. Publ., p. 23, f. 7.

Through the kindness of Professor Cockerell I have been enabled to see a slide from the type material of *Pseudococcus phoradendri* Ckll. There can be but little doubt that my *Lachnodius salicis* is the same.

Cryptoripersia arizonensis (Ehrh.)

1899. *Ripersia arizonensis* Ehrh., Can. Ent., **31**: 5.
1901. *Ripersia trichura* Ckll., Ann. Mag. Nat. Hist. (7), **7**: 55.
1911. *Eriococcus salinus* Ehrh., Can. Ent., **43**: 276.

1918. *Cryptoripersia salinus* (Ehrh.); Ferris, Calif. Species Mealy-Bugs, Stanford Univ. Publ., p. 74, pl. 3, f. 30.

1919. *Cryptoripersia arizonensis* (Ehrh.); Ferris, Contrib. Knowl. Coccidæ Sw. U. S., Stanford Univ. Publ., p. 34.

Professor Cockerell has kindly sent me a slide of his *Ripersia trichura* from the type material. This is structurally identical with *C. arizonensis* (Ehrh.). The fact that the specimens are smaller than *arizonensis* and were not enclosed in a sac may be taken merely as evidence that they were not fully grown.

The paper on mealy-bugs was received with much interest and a general discussion was entered into, led by H. S. Smith, E. M. Ehrhorn, A. A. Brock, R. S. Woglum.

CHAIRMAN H. J. QUAYLE: The next topic on the program is an illustrated lecture by Mr. D. B. Mackie, southern field deputy of the State Commission of Horticulture on "Migratory Locusts in the Philippine Islands." Mr. Mackie has had a large experience in entomological work in the Philippines and his talk will be very interesting I am sure.

(No paper was presented for publication.)

CHAIRMAN H. J. QUAYLE: This will end the program for this morning. The proceedings will be continued at the same place this afternoon beginning at 2 o'clock p. m. (Recess.)

Afternoon Meeting

The meeting was called to order by Chairman H. J. Quayle at 2 p. m. E. O. Essig acted as Secretary.

CHAIRMAN H. J. QUAYLE: The first paper this afternnon will be presented by Mr. Geo. M. List, whose subject is "The Alfalfa Weevil in Colorado."

(Paper withdrawn for publication elsewhere.)

CHAIRMAN H. J. QUAYLE: Prof. George P. Gray of the Insecticide Laboratory of the University of California has recently conducted some very interesting investigations relative to liquid hydrocyanic acid gas. He will present the next paper entitled "The Physical and Chemical Properties of Liquid Hydrocyanic Acid."

(Paper withdrawn for publication elsewhere.)

CHAIRMAN H. J. QUAYLE: Inasmuch as there are several other papers yet to follow on this subject of liquid hydrocyanic acid gas, I am going to suggest that we defer discussion until after all of the speakers have finished.

The next paper by Mr. R. S. Woglum of the Bureau of Entomology

is entitled "A Dosage Schedule for Citrus Trees with Liquid Hydrocyanic Acid."

(Paper not presented for publication.)

CHAIRMAN H. J. QUAYLE: The next paper is entitled "The Stratification of Liquid Hydrocyanic Acid as Related to Orchard Fumigation." It has been prepared by Mr. R. S. Woglum and M. B. Rounds both of the Bureau of Entomology and will be presented by Mr. Rounds.

THE STRATIFICATION OF LIQUID HYDROCYANIC ACID AS RELATED TO ORCHARD FUMIGATION

By R. S. WOGLUM and M. B. ROUNDS, *Bureau of Entomology, Department of Agriculture, Alhambra, Cal.*

The use in orchard fumigation in California of liquid hydrocyanic acid sometimes containing a large per cent of water has brought forth the question "Does this chemical ever stratify?" The prevalent opinion among those who have worked most with this active agent appears to be that stratification is improbable even when liquid hydrocyanic acid of widely different strengths or even liquid hydrocyanic acid and water are brought together in any proportion, and this view, at first, was accepted by the writers. The definite assertion to the senior writer by Mr. S. A. Stowell, an experienced fumigator, that he had drawn water and hydrocyanic acid from the same drum led to the outlining of a series of experiments in an endeavor to settle this point.

The first experiment which was performed by Mr. H. D. Young by slowly bringing together liquid hydrocyanic acid and tap water gave definite stratification. This preliminary experiment was followed by many others during which liquid hydrocyanic acid was added to tap and distilled water and vice versa; also liquid hydrocyanic acid of widely separated purities were brought together. In this work glass bottles were used each first being half-filled with material to which the second liquid was added slowly by means of a pipette. The bottles were not shaken. Typical experiments are herewith presented in brief.

In each of these eleven experiments stratification occurred regardless of the order in which the different liquids were added; the effect was similar whether the water was added to the hydrocyanic acid or the hydrocyanic acid to the water. Distilled water reacted in a manner similar to tap water. Each of these experiments was repeated and many others of like nature were performed. In every instance in

TABLE 1. TABLE REPRESENTING THE RESULTS OF EXPERIMENTS ON STRATIFICATION

Experiment Number	Size of Bottle	Liquid in Lower Half of Bottle	Liquid Added to Half-Filled Bottle	Cloudiness of Milky Appearance	Stratification
1	1 gal.	tap water	92% HCN	Yes	Yes
2	1 gal.	½ tap water ½ 50% HCN[1]	½ 92% "	"	"
3	1 gal.	½ 50% " [1]	½ 92% "	"	"
4	8 oz.	tap water	96% "	"	"
5	"	dis. water	96% "	"	"
6	"	96% HCN	dis. water	"	"
7	"	tap water	91% HCN	No	"
8	"	dis. water	91% "	No	"
9	"	50% HCN[1]	92% "	Yes	"
10	"	92% "	dis. water	No	"
11	"	92% "	tap water	No	"

[1] Cloudiness in sample formed by diluting 96 per cent hydrocyanic acid to make a 50 per cent solution.

which the liquids were brought together slowly, stratification occurred. One series of bottles left undisturbed for several weeks showed distinct stratificiation throughout this period. If, however, the materials were brought together violently and thoroughly shaken stratification was not produced.

When liquid hydrocyanic acid was allowed to flow slowly into water near the surface level it rose to the surface and did not mix freely with the water. Ultimately a layer or stratum was formed between the heavier lower liquid and the lighter upper one. When water was added slowly to liquid hydrocyanic acid it flowed through the liquid to the bottom of the bottle forcing the lighter chemical to the top, and showed a distinct stratum between the two liquids. In some cases this stratum between the two liquids was transparent and detected only by close examination, or agitation of the bottle. In other cases a cloudiness or milky appearance was observed when water and hydrocyanic acid were mixed and this precipitate ultimately collected in the middle layer to which it gave a whitish gelatinous appearance. (Pl. 14, fig. 1.) When allowed to stand in bottles undisturbed for a short time a vigorous shaking was necessary to break up this layer.

This milkiness occured only with liquid hydrocyanic acid taken from galvanized iron drums. A chemical examination of the acid taken from drums showed it to contain traces of zinc in solution whereas the liquid hydrocyanic acid which produced no precipitate had been in glass containers and upon examination was found to contain no zinc. Since zinc was in solution in the liquid hydrocyanic acid and since zinc compounds with cyanogen are known to be insoluble in water, it would seem apparent that the precipitate formed was some compound of this metal. The presence of a gelatinous precipitate

in the bottom of drums and in machines for applying the gas was often noted in field work during this past season, and was a source of interference with accurate action of the pump.

Actual proof of the fact that where liquids of widely varying purity are brought together stratification may take place and the relation thereto of zinc compounds present features of importance in field practice. In the first place only liquids of uniformly high purity should be used thereby to prevent stratification which might occur if materials of widely different strengths from two or more containers are poured together. Metals containing zinc should not be brought in contact with liquid hydrocyanic acid. When drums are washed out with water after use in the field they should be thoroughly dried before being refilled. Furthermore, that stratification may hasten decomposition is shown by one experiment in which a gallon bottle half full of tap water was filled with 92 per cent hydrocyanic acid from a galvanized iron drum. A few days following the experiment decomposition started immediately below the middle layer which held the precipitate and within two weeks the lower half of the bottle was dark brown in color. The top layer remained perfectly clear until the completion of the experiment when the bottle was discarded to avoid explosion.

CHAIRMAN H. J. QUAYLE: These three papers are now open for discussion.

PROF. GEO. P. GRAY: Our conclusions are the same regarding liquid HCN and its ability to stratify.

R. S. WOGLUM: There are a few rather interesting points which I wish to call your attention to in connection with our studies of liquid HCN.

Where the liquid is taken from iron drums the gelatine percipitate is hard to mix with the liquid HCN and stratification may be present when it is used.

There has been more daylight fumigation during the past summer with liquid HCN than ever before under the old system of fumigation. However I do not believe in daylight fumigation because the chances for burning are too great. In hot weather the gas from liquid HCN stays near the bottom of the tents and gives relatively better killings in the lower portions of the trees. At 40° F. the killing is rather poor, although it may be said that in lower temperatures the best killings are at the top of the trees.

CHAIRMAN H. J. QUAYLE: Our experiences show that there is less diffusion in low temperatures. At a temperature of 50° F. there

is a difference of 10 per cent between the top and bottom of the tent with the greater concentration and killing at the bottom. At a temperature of 70° F. there is better diffusion and a more even killing throughout the whole tent.

If there is no further discussion we shall pass on to the next paper which was to have been presented by Dr. H. P. Severin of the University of California. As he could not be present I am going to ask Mr. C. F. Stahl, of the Bureau of Entomology, U. S. Department of Agriculture, who is at present time located in Riverside studying the sugar beet leafhopper, and who has been doing considerable work on this insect for several years to read the paper which is entitled "Notes on the Behavior of the Beet Leafhopper."

MR. C. F. STAHL: Dr. Severin has prepared two very interesting papers on the beet leafhopper, both of which throw new light upon this insect. The title of the first paper has already been announced and the subject matter follows:

NOTES ON THE BEHAVIOR OF THE BEET LEAFHOPPER (EUTETTIX TENELLA BAKER)

By HENRY H. P. SEVERIN, PH.D., *California Agricultural Experiment Station*

SEXUAL BEHAVIOR

Dr. E. D. Ball[1] noticed a swarming of the beet leafhopper (*Eutettix tenella* Baker) "near Pauguitch, Utah, at an elevation of 7,000 feet, just at the time the immense swarms swept over the beet regions of Utah in 1915. They were first observed in the evening just as the sun was setting and at this time were flying around and hovering over a little patch of young pigweed"; this was interpreted as an evening rest while migrating. "The next morning they were there in numbers, but quite sluggish with the cold. When this patch was visited a little later they were gone and none could be found in the valley." This observation was made in a mountain valley "above the limit of beet raising and no doubt above the limit of their breeding range," and was located in the approach to a mountain pass leading over to the southern desert.

In California the writer saw apparently the same behavior at 130 feet below sea level in the Imperial Valley and frequently in the beet fields and also on the plains of the San Joaquin Valley. The behavior is associated with mating and was first studied at Heber in the Imperial Valley on June 3–9, 1918, where an enormous congregation of nymphs and adults had occurred on the Nettle Leaf Goosefoot (*Chenopodium*

[1] Ball, E. D., 1917. Utah Agr. Exp. Sta., Bul. 155, pp. 28–29.

murale) growing near dried *Atriplex elegans*. The different phases of the sexual behavior were observed through a reading glass having a diameter of six inches and a long focal distance.

During the week in which the sexual behavior was studied at Heber, the beet leafhoppers began to clean their bodies before sundown between 6.30 and 6.45 p. m. The wings were stroked and occasionally raised with the hind legs, the middle and front legs cleaning the rest of the body. Before sundown 20 adults were collected with a pipette while they were engaged in cleaning movements and of this number 12 were males and 8 were females. Even the nymphs were aroused to activity at sunset and cleaned their bodies.

On June 8, a partial eclipse of the sun caused a drop in the temperature but the cleaning reaction started at 6.30 p. m. Observations at Mount Wilson Observatory showed that the solar eclipse began at 2 minutes after 3 o'clock, and ended at 38 minutes after 5 o'clock. At the turning point, 4.21 o'clock, 74 per cent of the sun's surface was obscured.

After the male has cleaned his body he may rest for a time; he then walks forward a short distance at the same time fluttering his wings; he stops suddenly for an instant and moves forward again in the same manner and so on. During the week, 55 adults showing this behavior were captured with a pipette before sundown and all proved to be males. The males walked about on the stem, leaves and cluster of seeds and when one discovered a female he sidled up to her with wings elevated on one side of the body and endeavored to copulate. If the female is not inclined to mate, she may kick viciously with her hind legs at the male and if he persists in his attentions, she may walk or fly away. The male often takes short flights in seeking his mate. Sometimes a male may force his attention on a nymph and cause the latter to rear up the abdomen and kick with the hind legs or the nymph may walk or hop away.

After sundown on a calm evening, both male and female adults were aroused to an unusual activity and took short flights about the weed. Hundreds of leafhoppers on the wing swarmed about the plants. Many specimens came to rest on my clothes, face, hands and reading glass, but just for a few moments and then they took wing again. Twenty-three beet leafhoppers were taken on my clothes and of this number 18 were males and 5 were females.

After darkness had set in about 9 p. m. a light thrown on the Nettle Leaf Goosefoot with a flash light showed that the hoppers were at rest on the weed. During the nights of June 7–8, 49 specimens at rest were caught and of this number 25 were males and 24 were females.

The cleaning movements and sexual behavior were observed in sugar

beet fields at Le Grand on July 12, and at Manteca on August 31. At Le Grand the males took short flights from beet to beet or somewhat longer flights from 5–10 feet.

During the last week in October the sexual behavior was observed on the plains adjacent to about 50 square miles of Russian Thistles (*Salsola kali* var. *tenuifolia*) interspersed with patches of Fog Weeds (*Atriplex expansa*) growing in the vicinity of Oro Loma in the San Joaquin Valley. The plains extended about 3 miles to the foothills of the Coast Range and on both, the beet leafhoppers were captured on Red Stem Filaree (*Erodium cicutarium*) during the daytime. A quarter of an hour before the sun sank behind the mountains, an occasional adult was taken on the wing, but the number of flying specimens gradually increased after sundown (5.05 p. m.). The bugs did not orient themselves with reference to the light northwest wind but flew about in all directions. A person standing quietly on the plains soon became covered with hoppers but the insects seemed to be extremely restless, pausing for a short time and then taking wing again. The males flitted their wings in walking about but the females remained inactive. At one time 6 males circled around or sidled up to a female. At 5.15 the first pair in coition was taken and mating continued until dark. (See Plate 15.)

The windshield of an automobile attracted hundreds of beet leafhoppers after sundown and resembled the swarming of enormous numbers of insects around an electric arc lamp. An insect-net was moved back and forth in front of the windshield and the following proportion of male and female specimens were taken on the plains near Oro Loma on October 31:

Light males	Dark males	Light females	Dark females	Total
58	252	0	34	344
17%	73%		10%	

Does the sexual behavior occur at sunrise? Observations were made at sunrise during two mornings on the Nettle Leaf Goosefoot at Heber in the Imperial Valley. The mornings were cool and at sunrise the hoppers did not stir. An occasional specimen was noticed cleaning its body between 6–7 a. m. but no sexual activity was observed.

When beet leafhoppers were required from shrubby perennial Atriplex for experimental purposes, advantage was taken of the fact that the adults are aroused to activity at sunset and are taken more abundantly after sundown than during the daytime. One of many tests will be given. Two persons swept Cattle Spinach (*Atriplex polycarpa*) with an insect-net for an hour during the afternoon and the same shrubs were swept for half an hour after sundown with the following results:

CATTLE SPINACH, FOUR MILES SOUTH OF SHAFTER, OCTOBER 28, 1918

2.40 to 3.40 p. m.

Light males	Dark males	Light females	Dark females	Total
12	0	3	9	24
		5.15 to 5.45 p. m.		
56	4	5	61	126

In all probability, the hoppers remain within the shrubs during the daytime, and come to the outer branches and foliage at sunset.

During the summer a student was employed for a week to capture *E. tenella* on sugar beets and he caught as many leafhoppers after sunset when no heavy winds were blowing as he did during the entire day.

NOCTURNAL HABIT

E. tenella is a nocturnal insect and displays a considerable amount of activity at night. Tanglefoot fly paper was fastened to barren sandy soil and on boards attached about two feet above the ground at 9 p. m. in the vicinity of the Nettle Leaf Goosefoot on which an enormous congregation of nymphs and adults had occurred at Heber in the Imperial Valley. The next morning before daylight adults were found adhering to the fly paper.

The nymphs also move about at night and seek new food plants when the vegetation on which they are feeding becomes dry. Strips of tanglefoot fly paper were fastened to the sand at night midway between a dried patch of Nettle Leaf Goosefoot and a half dozen green plants. The next morning at 4 a. m. 9 nymphs and 5 adults were found on the fly paper.

There is some evidence to show that the nymphs will leave green plants and wander about on the ground at night. Strips of tanglefoot fly paper were fastened to the sand at night on all sides of an isolated Nettle Leaf Goosefoot plant, at a distance of one yard from the terminal end of the branches. The next morning before daylight 12 nymphs and 4 adults were found sticking to the fly paper.

During the night large numbers of nymphs and adults left green Nettle Leaf Goosefoot plants and were found on the sand below the weeds before daylight on the next morning. When tanglefoot fly paper was fastened to the sand directly below the branches at night several hundred nymphs and numerous adults were found the next morning. Nymphs and adults, however, were also abundant on the stems, leaves and cluster of seeds of this weed at 4 a. m. Do the hoppers seek the warmth of the sand during the night?

Reaction to Heat

It is a well known fact that the larvæ of certain pests are killed when they come in contact with soil on hot days and hence several trials were made with nymphs of *E. tenella*. In one test 100 nymphs collected on the Nettle Leaf Goosefoot at Heber in the Imperial Valley were dropped on soil in a depression which had been irrigated and baked into a hard crust. When the insects came in contact with the hot ground they hopped about at a lively rate. A large specimen was followed and it soon became evident that the distance of each leap became shorter and shorter. Oftentimes the hopper fell on its back after a jump and experienced difficulty in righting itself. At the end of 20 minutes the creature was lying on its back and made no further effort to move. It had hopped 15 feet from the point of liberation. The experiment was repeated several times and in each case the nymph died. The thermometer registered 110° F. in the shade.

Phototaxis

On rare occasions the beet leafhopper is attracted to electric lamps. At Coalinga in the San Joaquin Valley, the adults were taken on a glass show case situated below a 200 watt "Daylight Lamp," on show windows and in bowls enclosing incandescent electric lamps fastened to the ceiling at the entrance of stores. The following figures give the proportion of sexes:

	Males	Females	Total
July 15/18	3	26	29
Aug. 3/18	21	113	134
	24	139	163
	14%	85%	

At Coalinga the adults showed a positive reaction to an auto spot light and left the Fog Weed and congregated on the soil illuminated by the lamp. When the spot light was held a few feet from the hoppers some of the specimens flew to the light. Similar results were obtained near Shafter on July 18.

In the Imperial Valley enormous numbers of Jassids were attracted to electric lamps in cantaloupe packing sheds on calm evenings. A single female beet leafhopper was captured at Heber on June 7, but not another specimen was taken from June 8–15.

Reaction to Shadow

When a person walked past a Nettle Leaf Goosefoot plant a swarm of adults flew up, some settled on the ground but most of them came to rest upon the weed. Before and after sunrise, however, the hoppers

did not respond, probably due to the lower temperatures. When a person stood perfectly quiet near a plant and a shadow was thrown on the weed, some of the leafhoppers immediately flew about. When an insect-net was moved about but without casting a shadow upon the plant, the bugs did not fly from the weed. Evidently the insects do not respond to a moving object but a shadow arouses some of them to activity.

CHAIRMAN H. J. QUAYLE: I see Prof. Doane is here now. We will listen to his paper on "Weevils in Australian Wheat in California."

WEEVILS IN AUSTRALIAN WHEAT IN CALIFORNIA

By R. W. DOANE, *Stanford University, California. Collaborator, Bureau of Entomology, U. S. Department Agriculture*

The great demand for vessels of all kinds that came with the beginning of the late war soon interrupted the normal movement of foodstuffs in all parts of the world. In a very short time the serious results of this restricted movement began to be apparent in many quarters. Vast quantities of food that were badly needed elsewhere began to accumulate in certain centers where no provision was ever made to handle it in such unusual amounts.

One of the most serious situations brought about by this condition was the accumulation of millions of bushels of wheat in the Australian and New Zealand seaports, where most of it had to lay for many months; some for three or four years, awaiting shipment. It was inevitable that the weevils and other insects should take advantage of such an opportunity to wax fat and multiply.

I have not seen any account of the work that has been done in Australia in the efforts to control the weevils there, but I have had an opportunity to inspect much of the wheat that has come into San Francisco and Los Angeles from Australia, and to see the way in which the mills here handle the infested grain.

The wheat was imported by the Grain Corporation of the United States Food Commission, and sold to the mills that seemed to need it most. Most of it went to mills in San Francisco and Vallejo, but some went to Stockton and some to Los Angeles and vicinity, and smaller amounts to Oregon and Arizona. All of the mills receiving this wheat were working on government contracts, furnishing the government a certain amount of flour or other products. The Grain Corporation assumed no control over the wheat after it was taken from the docks by the mills.

The first few lots of this wheat came on some of the steamers that ply regularly between San Francisco and Australia. These steamers make the trip in about twenty days. Most of the wheat, however, has been shipped on sailing vessels requiring eighty or ninety days or more to make the trip. I am told that one vessel was at sea nearly six months before it finally reached San Francisco.

Of course these long trips, mostly through tropical waters, give time for the wheat to become thoroughly warmed. Unfortunately we did not take any temperature tests in the holds of these vessels, but several times it was found that the wheat in the sacks would feel very warm and this heat would be retained for several hours after the sacks were stacked on the docks. So the number of insects in these cargoes was doubtless much greater when the ships reached San Francisco than when they left Australia, as conditions were almost ideal for their development. But the great amount of wheat that had been cut by the weevils and the masses of insects that were found on and throughout the sacks that came on the steamers in the earlier shipments, showed that most of the damage must have been done while the wheat was still in storage in Australia.

There was a great deal of difference in the amount of infestation in the different sacks in all of the shipments. Some sacks showed but little injury due to the beetles, in other sacks we would find 80 per cent to 90 per cent of the grain injured or destroyed by the weevils. A handful of the grain taken from the sack would sometimes contain from six to fifteen or more weevils. These badly infested sacks were usually covered with the beetles that were coming from the wheat, and the flour or dust from the injured grains was sifting through the exit holes made by the beetles.

In San Francisco most of this wheat was hauled from the docks to the mills and carried by conveyers directly to the bins where it was stored until needed. Usually the miller began to draw on this supply at once, for few, if any, of the companies had any reserve. Before the wheat was stored in the bins it passed through screens to take out the straws, unthrashed heads and other large rubbish. As it was drawn off for use it passed through suction cleaners that drew off the light grain, weed seeds, weevils, etc. These screenings were placed in sacks and disposed of in various ways. If they contained a good deal of grain they were often sold for chicken or hog or sheep feed, or ground in the atrition mill for ground feed. Some of the lots that contained but little wheat and much smut and many beetles and weed seeds, were burned or thrown into the bay.

Although we all recognized that burning was the safest way to handle these screenings, it did not seem advisable to destroy the lots

that contained a considerable amount of wheat that might be used for feed, especially if we could in some way destroy the beetles so they would not be a source of danger wherever the feed was used.

Carbon bisulphide could not be used for this purpose as the mills would not take the fire risk. Cyanide seemed to be out of the question as the screenings were so finely packed in the sacks that it would be very hard, if not impossible, to get sufficient penetration of the gas, unless the vacuum system was used and that was considered too expensive for the purpose.

We urged that all of the mills that were handling this wheat make some provision for treating the screenings with heat to destroy the insects and some of them complied with this request. One firm, instead of building a small room or partitioning off a small part of a large room, constructed a tight box 16 feet long, 5 feet high and 3 feet from front to back. The front side of the box was provided with eight doors which opened practically the whole side of the box. These doors were secured by fasteners which clamped them close to their frames when closed. There was shelf room for 16 sacks of wheat in this box. Close to the bottom were 28, 9-foot lengths of 3/4-inch pipe. The cost of such a box including material and labor was about $200. The engineer said that the cost of operating it was inconsiderable as it took but little steam to maintain the required temperature.

The sacks of screenings to be treated were placed in this box about 9 o'clock in the morning and left there until 3 or 4 o'clock of the same day, sometimes they were left there until the next morning. The steam was turned on as soon as the box was filled and left until 4.30 or 5 o'clock in the evening.

An examination of the screenings that had been subjected to this treatment showed that, when the sacks were left in the box for only six or eight hours, all of the beetles were not killed, but when they were left in twelve hours or longer, no living insects could be found. A series of tests and experiments showed that with a steam pressure of 80 pounds the temperature in the box was raised to about 53° C. in a very short time; with an increased pressure the temperature rises very rapidly. With 150 pounds pressure the thermometer soon read 90° or 92° C.

The weevils and other beetles that were on the outside of the sacks began to die when the temperature reached 50° to 52° C. and before it reached 60° C. all that were exposed were dead. But it was found that the heat penetrates the screenings very slowly, so that after an exposure of six hours to a temperature of 53° to 80° C. a thermometer that had been placed in the center of the sack showed no increase of temperature. After about seven or eight hours the heat began to

reach the center of the sack and in about twelve or fourteen hours the temperature would go as high as 53° to 58° C. while the temperature in the box outside the sacks would be 80° to 90° C. Under these conditions all the insects in the screenings were killed.

The screenings after being taken from the hot-box gave up their heat, seemingly, as slowly as they took it, for we found that the temperature in one of the sacks dropped only 3° C. in five hours, although the sack was placed near an outside door in a cool store room.

The results of these experiments showed that with a box as described above and with a steam pressure of 80 to 150 pounds the screenings should be exposed to the heat twelve hours.

One of the Los Angeles mills built a small brick walled room about 6 feet by 10 feet by 8 feet high. It was heated by short coils of pipe on one side of the room 4 or 5 feet from the floor. The cost of building this room and installing the pipes was about $225. The miller said that it took several hours to heat the room and that he had found it necessary to raise the temperature to 190° F. (88° C.) in order to kill the insects. The thermometer from which his readings were taken was placed on the wall near the steam coils and on the same level with them. Tests made with other thermometers showed that one placed on a level with the coils but some distance from them, soon reached 71°C. Another placed about 2 feet from the floor, on a sack of screenings registered 48° C. while a third that had been thrust into the center of the sack of screenings registered only 28° C. This showed that the unusual and unsatisfactory results that were being obtained were due to the steam coils being placed high on the sides of the wall, instead of on the floor or very close to it. It is believed that when these coils are placed lower down, as recommended, no further trouble will be met with.

Some other mills have already installed, or propose to install, small heat rooms for treating infested flour or other material that may be returned to the mill from dealers or elsewhere.

One company has been spraying all of the Australian wheat received by its various mills with carbon tetrachloride. The work is done with small hand pumps and the wheat is sprayed as it is poured from the conveyers into the bins. The aim is to use about 2 gallons of the liquid to about 1000 bushels or 30 tons of the grain. In this way they figure that the cost of the material for treating a ton of grain is about 20 cents. If the bins in which wheat, that has been treated in this way, is stored, are tight and can be kept closed for a few days, nearly all of the weevils are killed. If the wheat is drawn from the bins within twenty-four or thirty-six hours after it has been treated, many live weevils are often found. The wheat should lie in the bin at least

two or three days to insure satisfactory results. This company reports that careful tests show that the milling qualities of wheat treated in this way are not affected.

The Rice Weevil, *Calandra oryzae*, is the most common beetle found in all of the shipments of Australian wheat, that I have examined. In some lots the grain weevil, *C. granaria*, was also very abundant, in other shipments but few were found. The saw-toothed grain beetles, *Silvanus surinamensis*, were always abundant. The confused flour beetles, *Tribolium confusum*, were common in all shipments, and *T. ferrugineum* was also often quite common. The lesser grain-borer, *Rhizopertha dominica*, was always quite abundant and apparently very destructive. The flat grain beetle, *Laemophloeus minutus*, was common in all lots. The cadelle, *Tenebroides mauritanicus*, and a few other beetles were more or less common.

Mesaporus calandrae How., the cosmopolitan parasite of grain weevils, was common on nearly all lots of Australian wheat examined and it was exceedingly abundant in some of the lots.

CHAIRMAN H. J. QUAYLE: There are a number of papers on file with the Secretary to be read. Inasmuch as the authors are not present to read these papers, I am going to ask the Secretary to read them by title only. They will be included in the proceedings and can be read by all of us at some future time.

INVESTIGATIONS OF THE BEET LEAFHOPPER (EUTETTIX TENELLA BAKER) IN CALIFORNIA

By HENRY H. P. SEVERIN, PH.D., *California Agricultural Experiment Station*

I. INTRODUCTION

Where do the enormous numbers of beet leafhoppers (*Eutettix tenella* Baker), which invade the cultivated districts, come from in the spring? Where do the hoppers go in the autumn after leaving the cultivated area and where do they spend the winter? These are questions that have been asked repeatedly by agriculturists and have baffled scientists during the past thirteen years. Are there other plants from which the leafhoppers transmit curly leaf disease to sugar beets? These subjects and a consideration of the life history and related topics will receive attention.

In California, Dr. E. D. Ball (1), former director of the Utah Agricultural Experiment Station, endeavors to trace the origin of the pest in the beet fields through migrations from desert breeding areas in the

Death Valley, Mojave Desert, Imperial Valley, Tulare Lake and Bakersfield sections of the San Joaquin Valley.

II. Death Valley

We (3) have published the results of our investigations conducted in the Death Valley on January 27–31, 1918. At this time of the year no specimens were taken on desert vegetation from Ryan to Keane Wonder, a distance of 38 miles, and on vegetation growing in the cultivated districts at Furnace Creek ranch situated midway between the two towns.

III. Antelope Valley and Mojave Desert

During the winter and spring of 1918, trips were taken into the Antelope Valley and Mojave Desert to ascertain the abundance of the pest under desert and cultivated conditions and on vegetation growing along the Mojave River. During the winter the leafhopper was extremely scarce on desert vegetation in the Antelope Valley and Mojave Desert. In the vicinity of beet land, the adults were collected abundantly on desert vegetation during January but in March only a single specimen was captured on Rabbit Brush (*Chrysothamnus graveolens*) growing along the Mojave River. In the cultivated area of the Antelope Valley, the hoppers were commonly taken in piles of blighted sugar beets near Lancaster on January 7.

In the spring, plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs, made their appearance in the cultivated area and on these enormous numbers of beet leafhoppers were present. The bugs were far more abundant on *Atriplex bracteosa* growing near beet fields than on the sugar beets. The insects were commonly taken on the Fog Weed (*Atriplex expansa*), *Atriplex rosea* and Russian Thistle (*Salsola kali* var. *tenuifolia*) growing along railroad tracks.

The results show that instead of a migration of *E. tenella* from the Mojave Desert, an invasion of enormous numbers into the cultivated area occurred between March 17 and June 12. The beet leafhoppers of the spring brood can usually be detected from the winter forms, the former are pale green or cream colored, whereas the latter are dark in color,—especially the females. A considerable amount of individual variation occurs in the color pattern.

IV. Imperial Valley

We (3) have published the results of our investigations carried on in the Imperial Valley during the winter of 1918, and a brief account of the work conducted in this region during the spring will now be given. The beet leafhopper was extremely scarce on desert plants and on

vegetation growing along rivers. In the cultivated area, the hoppers were commonly taken on the Australian Saltbush (*Atriplex semibaccata*), a perennial plant which remains green during the winter, and grows along irrigation canals, roadsides, railroad tracks, fences and in vacant fields. In all probability, many millions of leafhoppers occur on this plant in the Imperial Valley.

The bugs will leave green succulent plants without an apparent stimulus. On March 13–April 21, the pest was abundant on the Lowland Purslane (*Sesuvium sessile*) at Niland, but on June 10, the hoppers had left not only the dry plants but also the young succulent plants growing among the older ones. Sweepings from plants of the Saltbush and related families indicated that apparently a dissemination of the insects to these plants had occurred.

An enormous congregation of the beet leafhoppers occurred on *Atriplex elegans*, a short lived annual plant, which makes its appearance in the spring in the irrigated districts of the Imperial Valley. At Heber the plants were dry on June 3, and the insects had left the vegetation. An attempt was made to locate the bugs. As one walked past patches of Nettle Leaf Goosefoot (*Chenopodium murale*) growing among and near dried *A. elegans* a swarm of leafhoppers flew up. In localities where *A. elegans* was not present, the pest did not occur in large numbers on the Nettle Leaf Goosefoot.

It is not to be assumed, however, that when *A. elegans* becomes dry the insects always congregate in enormous numbers on green plants in the vicinity. A long narrow tract of *A. elegans* bounded on one side by desert vegetation and on the opposite side by a field of alfalfa was found about 2 miles southwest of Niland. W. W. Thomas states that he captured about 500 specimens in 25 sweeps of the insect-net on these plants on April 21. On June 10, the writer visited the locality and all of the plants were dry except in shady places under bushes. The hoppers had left the dried *A. elegans*. In the neighborhood of the dried vegetation not more than a dozen adults and nymphs were collected each time patches of Nettle Leaf Goosefoot were swept. A few *A. rosea* were growing among the dried plants and along roadsides but no bugs were taken from these. No beet leafhoppers were found on cultivated plants or weeds or on desert vegetation in the vicinity.

Two explanations may be given as to the origin of the enormous numbers of beet leafhoppers on *A. elegans* in the Imperial Valley. The hoppers may have congregated on *A. elegans* from plants growing in the cultivated area of the Imperial Valley, such as the Australian Saltbush and Lowland Purslane, or the pest may have invaded the cultivated area from other breeding grounds. During March, the dark winter adults were far more abundant than the pale green or

cream colored forms of the spring brood, but in April the pale green or cream colored insects greatly out-numbered the dark bugs. No attention has been given to the canyons, foothills and mountains surrounding the Imperial Valley.

In the Imperial Valley, *E. tenella* has been bred from the Lowland Purslane, Australian Saltbush, and *A. elegans*. During the winter and spring only 15 beet leafhoppers were taken on 7 species of desert plants, 3 of which were perennial Atriplex. In the cultivated area, the insects were collected on 17 species of plants, 6 of which belong to the Saltbush family. The pest was most abundant on different species of Atriplex and Chenopodium.

V. San Joaquin Valley

Natural Breeding Area

While the writer was engaged in a grasshopper survey of the state of California in the spring of 1917, large numbers of Jassids were sometimes found on the plains and foothills. Two trips were taken in the San Joaquin Valley, the first on April 23–May 7, and the second on May 21–28. A small paper bag was fastened in the bottom of the insect-net and the insects which were swept from the vegetation dropped into this bag. A few bags of these sweepings were examined by Mr. Thomas but no *E. tenella* were found and on account of other work the material was set aside for examination during the winter. Up to the present time 250 bags of sweepings collected in various localities on the plains and foothills of the San Joaquin Valley have been examined with the following results:

April 25/17. 12 miles south Los Banos, 1 dark female *E. tenella*.
April 25/17. 17 miles south Los Banos, 1 dark female *E. tenella*.

Mr. Thomas discovered large numbers of adults of *E. tenella* on pasture vegetation on the plains in the vicinity of Coalinga on May 9, and Professor R. E. Smith found nymphs commonly on stones in the warm sunshine. A trip was made to determine whether the pest was local or general on pasture vegetation throughout the San Joaquin Valley. On May 16–21, about 700 miles were covered in an automobile by W. J. Hartung, Thomas and the writer and from 1–50 leafhoppers were taken with about 25 sweeps of the insect-net on Red Stem Filaree (*Erodium cicutarium*) growing on the plains, canyons and foothills in various localities on the west side of the San Joaquin Valley.

G. T. Scott and Thomas found a congregation of the beet leafhopper on *Artiplex coronata* on June 22, growing among the Spiny Saltbushes (*Atriplex confertifolia*) at Helm. On this date the Filaree was dry with few exceptions at Coalinga and most of the hoppers taken were males.

On our next visit to Helm on July 16, *A. coronata* was dry and the insects had disappeared from the plants. After the pasture vegetation became dry, an occasional specimen was taken on green annual and perennial plants growing among the dried Filaree on the plains and foothills during the summer.

The beet leafhopper was bred in large numbers from Red Stem Filaree growing under natural conditions near Coalinga. The plants were collected on May 22, and the adults were reared on June 25, in the hothouse. *E. tenella* was taken on 20 species of plants growing on the plains and foothills, 5 of which belong to the Saltbush family. The insects were found most abundant on Red Stem Filaree.

Invasion of Beet Leafhopper in Cultivated Area

A brief account of the number of beet leafhoppers present in the cultivated area of the San Joaquin Valley up to the time of the invasion of the pest will be given.

Throughout the winter, the leafhopper was taken in small numbers by striking the foliage of blighted beets a few blows with the hand or by shaking the leaves. During the first three months of the year, dark colored specimens were captured on beets planted in December at Manteca by Hartung.

Professor Smith, Dr. E. Carsner and Thomas were unable to find a single beet leafhopper in the beet fields at Connor, Corcoran, Goshen Junction, Chowchilla and Manteca on April 7–11, but a small percentage of curly leaf was observed in the beet fields at Connor and Manteca. No hoppers were collected on green vegetation in the cultivated territory. Hartung and the writer found that 4 per cent of the beets planted in December were blighted at Manteca on April 22. On this same date no adults were caught but nymphs were found on diseased beets. From the evidence at hand, apparently no adults of *E. tenella* were present in the cultivated districts in the localities investigated by the various scientists on April 7–22.

On April 24–25, Hartung found large numbers of pale green or cream colored hoppers in the beet fields at Le Grand, where a few weeks previously no adults occurred. Pale green or cream colored specimens were taken on plants of the Saltbush and related families at Coalinga on May 9, but more abundantly on these plants in the cultivated regions on May 16–21.

After the invasion of the pest into the cultivated sections, the hoppers were far more abundant on different species of Atriplex than on any other plants of the Saltbush family. The vast area of Atriplex along railroad tracks, roadsides, fences, in grain, alfalfa and vacant fields, alkali sinks, near hay and straw stacks far exceeds the beet

acreage in the San Joaquin Valley. A conservative estimate of the number of leafhoppers in the beet fields in 1918, compared with the enormous numbers found on the Fog Weed, *A. rosea* and *A. bracteosa* in the San Joaquin Valley would be 1: 1000.

In the spring the beet leafhopper was found in enormous numbers on short-lived annual Atriplex, such as *A. cordulata* and *A. coronata*. At Volta, *A. cordulata* was growing in an alkali sink and when these plants became dry, the nymphs and adults probably moved to the Fog Weed also growing in the basin, and the same apparently was true in a sink at Cholame,—when *A. coronata* became dry the nymphs and adults probably congregated on the Fog Weed. In irrigated districts, the insects were commonly taken on *A. coronata* and *A. phyllostegia* during the middle of July, but when these plants bear seeds the hoppers gradually disappear. It was frequently noticed that when the stems of other species of plants became woody the bugs left, but this was not the case with the Fog Weed, *A. rosea* and *A. bracteosa*, the leafhoppers often remaining on these three species of plants until the leaves became dry.

The beet leafhopper was captured on 30 species of plants in the cultivated area, 18 of which belong to the Saltbush family. The pest was most abundant on different species of Atriplex.

E. tenella was bred from a large number of plants growing in the cultivated area of the San Joaquin Valley. The weeds were collected in vacant fields, stubble fields, beet fields, truck crop fields, along roadsides, railroad tracks, rivers, irrigation and drainage canals. About a dozen weeds of each common species were gathered at random and each species was placed in a large paper bag. In the hothouse the roots of the plants were put into a tumbler or jar of water and placed in a cage together with a potted sugar beet. The weeds and beet were watered daily through a hole in the cheese cloth on the top of the cage and then the hole was plugged with cotton. Caterpillars and spiders were removed from the cages. It is evident that the eggs were deposited in the vegetation under natural conditions, and by this method the females were not forced to oviposit in the plants. The insects were reared to the adult stage. Table I gives a list of plants in which the beet leafhopper deposited its eggs in the cultivated districts of the San Joaquin Valley.

TABLE I—PLANTS IN WHICH BEET LEAFHOPPER DEPOSITED EGGS, IN CULTIVATED AREA OF SAN JOAQUIN VALLEY

Name of plant	Locality plants collected	Date plants collected 1918	Date adults were bred 1918
Wire Grass	Manteca, beet field	July 11	Aug. 13
(Polygonum aviculare)			
Curly Dock	Connor, beet field	July 18	Aug. 27
(Rumex crispus)	6 miles southeast Manteca	Sept. 6	Oct. 18
Nitrophila occidentalis[1]	10 miles north Goshen Jct.	May 20	June 25
	Manteca, beet field	July 11	Aug. 8
	Le Grand, beet field	July 13	Aug. 26
Lamb's Quarters[1]	Manteca, beet field	Aug. 12	Oct. 3
(Chenopodium album)			
Nettle Leaf Goosefoot[1]	Coalinga	May 22	July 23
(Chenopodium murale)	Chowchilla	July 14	Aug. 18
	Volta	July 16	Aug. 15
	Connor, beet field	July 18	Aug. 27
Chenopodium leptophyllum[1]	Le Grand, beet field	July 13	Aug. 17
	Manteca, beet field	Aug. 12	Oct. 3
	5 miles southeast Manteca	Sept. 6	Nov. 1
Mexican Tea[1]	Manteca, beet field	July 11	Aug. 15
(Chenopodium ambrosioides)	Manteca, beet field	Aug. 12	Oct. 4
Atriplex rosea[1]	Chowchilla	May 21	June 25
	3 miles south Manteca	Sept. 16	Oct. 22
Atriplex phyllostegia[1]	12 miles west Wasco	May 19	July 8
	2 miles south Angiola	May 20	June 27
	4 miles west Corcoran	May 20	June 27
	Chowchilla, beet field	May 21	June 27
Atriplex coronata[1]	1 mile south Allensworth	May 20	June 27
	Chowchilla	July 14	Aug. 27
Fog Weed[1]	4 miles west Corcoran	May 20	June 27
(Atriplex expansa)	Manteca, beet field	Sept. 5	Oct. 22
Atriplex minuscula[1]	Earlimart	July 17	Aug. 17
Atriplex bracteosa[1]	Manteca, beet field	July 11	Aug. 18
	11 miles east Los Banos	July 14	Aug. 10
	Coalinga	July 16	Aug. 13
	Manteca, beet field	Sept. 5	Oct. 22
Australian Salt Bush[1]	2 miles west Wasco	May 20	July 1
(Atriplex semibaccata)			
Suaeda depressa var. erecta[1]	Manteca	Sept. 5	Oct. 22
Russian Thistle[1]	6 miles west Corcoran	May 20	June 26
(Salsola kali var. tenuifolia)	Chowchilla	July 14	Aug. 16
	Oro Loma	July 15	Aug. 15
	Manteca, beet field	Sept. 5	Oct. 22
Rough Pigweed	Manteca, beet field	July 11	Aug. 15
(Amaranthus retroflexus)			
Tumble Weed	Le Grand, beet field	July 13	Aug. 16
(Amaranthus graecizans)			
Amaranthus deflexus	Le Grand, beet field	July 13	Aug. 26
	Manteca, beet field	Sept. 5	Oct. 22
Indian Chickweed	Manteca, beet field	Aug. 12	Oct. 3
(Mollugo verticillata)			
Lowland Purslane	Connor	May 19	June 26
(Sesuvium sessile)	Connor, beet field	July 18	Aug. 27
Red Maids	Chowchilla, beet field	May 21	June 25
(Calandrinia caulescens var. menziesii)			
Charlock	Manteca, beet field	July 11	Aug. 16
(Brassica arvensis)	Manteca, beet field	Aug. 12	Oct. 3
	5 miles southeast Manteca	Sept. 6	Oct. 23

[1] Plants of the Saltbush Family (Chenopodiaceæ), to which the sugar beets belongs.

Stink Weed (Wislizenia refracta)	Chowchilla	July 14	Aug. 18
Spanish Clover (Lotus americanus)	Manteca, beet field	July 11	Aug. 15
Red Stem Filaree	4 miles west Corcoran	May 20	June 25
(Erodium cicutarium)	Chowchilla	May 21	June 25
	Coalinga	May 22	June 27
Cheese Weed (Malva parviflora)	Coalinga	May 22	June 27
Alkali Mallow (Sida hederacea)	Connor, beet field	July 18	Aug. 18
Chinese Pusley	Manteca, beet field	July 11	Aug. 15
(Heliotropium curassavicum)	Connor, beet field	July 18	Aug. 18
	Manteca, beet field	Sept. 5	Oct. 22
Tolguacha, Jimson Weed	Manteca, beet field	July 11	Aug. 16
(Datura meteloides)	Le Grand, beet field	July 13	Aug. 15
	Coalinga	July 16	Aug. 10
	7 miles southeast Manteca	Sept. 6	Oct. 18
May Weed (Anthemis cotula)	Coalinga	May 22	June 27
Common Spikeweed (Centromadia pungens)	Chowchilla	July 14	Aug. 27
Common Sunflower	Manteca, beet field	July 11	Aug. 16
(Helianthus annuus)	Le Grand, beet field	July 13	Aug. 15
Spiny Clothbur	Manteca, beet field	Aug. 12	Oct. 3
(Xanthium spinosum)	Manteca, beet field	Sept. 5	Oct. 23
	7 miles southeast Manteca	Sept. 6	Oct. 18
Horseweed (Erigeron canadensis)	Chowchilla	July 14	Aug. 26

Return Flight from Cultivated to Natural Breeding Area

As the food plants of *E. tenella* become dry in the cultivated area, the adults leave the vegetation. Our earliest record of the disappearance of enormous numbers of beet leafhoppers from the Fog Weed occurred between September 25 and October 10. The Fog Weed was growing in an alkali sink near Cholame, situated in a mountain pass between the San Joaquin and Salinas Valleys. The basin covered about ten square miles and was surrounded by mountains. No specimens were collected on green vegetation growing in and on the outskirts of the sink on Octoger 10. The two cotyledons of Filaree were just appearing above the surface of the soil in the washes of the foothills but no bugs were taken. If the leafhoppers left Cholame Valley, then the insects either flew over the mountains or followed the passes.

During the summer, trips were taken to the vicinity of Oro Loma, where enormous numbers of leafhoppers were present on about 50 square miles of Russian Thistles interspersed with patches of Fog Weeds. During the last week in October, the bugs were still abundant on green Fog Weeds and on small Russian Thistles with the tops of the plants dry and the lower portions green. An unusually large number of insects had congregated on the Australian Saltbush growing along the roadsides. The hoppers were common on Filaree growing below

the Russian Thistles. Adjacent to the western margin of this large area of weeds were the plains which extended about 3 miles to the foothills and on both, the adults were often taken on Filaree.

It is not to be assumed that the hoppers are found only on the foothills along the margin of the San Joaquin Valley. In crossing the Coast Range through the Altamont Pass, the adults were taken on Filaree growing on the foothills situated about 4 miles from the western margin of the San Joaquin Valley.

During the winter *E. tenella* was not found on foothills which were densely covered with green vegetation but the hoppers seek those hills which are sparsely covered with Filarce. As a general rule, the leafhoppers were taken on foothills which were exposed to the sunshine during the morning and afternoon. In all probability, the position of one hill to another with reference to sunshine determines the choice of location for the winter.

During the last three months of the year the beet leafhoppers were found on Filaree growing on the plains or foothills in the following localities on the west (Coast Range), south (Tehachapi Mts.) and east (Sierra Nevada Mts.) sides of the San Joaquin Valley:

Nov. 13	Foothills south and west of Tracy.
Dec. 10	Foothills 13 miles southwest of Tracy.
Dec. 24	Foothills 13 miles southwest of Tracy.
Oct. 25	Base of foothills, west of Dos Palos.
Oct. 25	Plains and foothills west of Oro Loma.
Oct. 28	Plains 7 miles north of Bakersfield.
Oct. 29	Plains 3–10 miles west of Lost Hills.
Oct. 30	Plains and foothills in the vicinity of Tejon Pass.
Dec. 13	Plains 21 miles south of Bakersfield.
Oct. 30	Plains and foothills east of Famosa to Bakersfield.

If we correlate the facts discovered in the natural and cultivated portions of the San Joaquin Valley, one would not hesitate to make the following statements: After the pasture vegetation became dry on the plains and foothills, the beet leafhoppers flew into the cultivated districts. During the summer an occasional specimen was taken on the various plants growing on the plains and foothills, showing that not all of the hoppers leave their natural breeding grounds. The invasion of the pest into the cultivated sections began on April 24, continued until May 21, and probably later. The gradual disappearance of the bugs in the cultivated regions during October corresponded with the reappearance of the insects under natural conditions. All of the adults do not leave the cultivated localities and last spring these caused 4 per cent of blighted beets at Manteca. Apparently no adults were present in the cultivated area from April 7–22, but nymphs were found

on curly leaf beets. In all probability, the females wintering over in the cultivated territory deposited their eggs and died, and the nymphs which were observed on April 22, hatched from these eggs.

When to Plant Beets

The fact that most of the beet leafhoppers leave the cultivated area in the autumn has an important bearing with reference to the time of planting beets. Sugar beet agriculturists are well aware of the fact that when beets are planted in November, December and January in the San Joaquin Valley, if weather conditions are favorable for planting early, a good crop can usually be obtained. The weather conditions are the determining factor with reference to planting from November to January. Last year no heavy rains fell in the San Joaquin Valley until February 22, and hence early planting was not practicable. The present rainy season started unusually early and heavy rains fell on September 11–13. The most serious objections to planting early are as follows: (1) the young beets are sometimes destroyed by frost necessitating replanting; (2) about 75 per cent of the beets planted in November, 50 per cent in December and 15 per cent in early January develop seed stalks which slightly reduces the sugar contents and furthermore, these beets are woody and difficult to slice.

In the Imperial Valley *E. tenella* was abundant on the Australian Saltbush during the winter. A similar observation was made on several acres of this perennial Atriplex growing near Wasco but 75 per cent of the specimens collected on December 10, and 82 per cent on February 16, proved to be males. Evidently the adults do not leave this plant in October and fly to the plains and foothills. The Australian Saltbush was introduced from Australia as a forage plant and birds are said to distribute the seeds. If this plant spreads to the beet districts there is a possibility that early planted beets may become badly blighted.

Do heavy rains kill the beet leafhopper? At Manteca $3\frac{3}{4}$ inches of rain fell before the return flight of the insects to the natural breeding grounds had commenced. In sugar beet fields, an occasional adult was observed with wings spread and partly embedded in the sandy soil below the leaves of blighted sugar beets. Dead specimens were found in the folds and below dried leaves. Dead hoppers partly embedded in the soil were also commonly taken below branches of *A. bracteosa* and in 40 minutes, 30 adults were collected. Evidently the creatures crawled below the branches to escape from the rain. Dead nymphs were rarely found but these were probably difficult to detect. An examination of the bugs under a binocular microscope showed that 50 per cent had been parasitized. The material was dry and could not

be dissected to determine whether the remaining 50 per cent were not weakened forms that had parasitic larvæ within their bodies. Insects at the end of their natural life often become sluggish and inactive and of all of the leafhoppers taken only one dark form of the winter brood was found.

VI. Plants from Which the Beet Leafhopper Transmitted Curly Leaf to Sugar Beets

Boncquet and Hartung (2) have shown that 100 leafhoppers collected on species of Artemisia and Atriplex in the Tulare Lake region of California and confined singly in cages on beet seedlings failed to produce curly leaf until they had fed on diseased beets. Smith and Boncquet (4) tested fully 2,000 insects taken on *Atriplex tularensis* and *Chenopodium album* in the Tulare Lake region on several hundred different sugar beet plants without the production of curly leaf in a single instance. The writer has confirmed this result with hoppers captured on different species of plants but adults and nymphs were frequently caught which produced the beet disease. The beet leafhoppers were taken in the natural breeding areas, cultivated districts and deserts. Table II, gives a list of plants on which specimens of *E. tenella* were collected and transmitted curly leaf to sugar beets.

Table II—Plants on Which Beet Leafhoppers were Collected and Transmitted Curly Leaf to Sugar Beets

Name of plant	Locality beet leafhoppers were collected	Number of adults or nymphs	Date E. tenella captured 1918
Atriplex elegans[1]	Niland	200 adults	Apr. 21
	Niland	25 nymphs	Apr. 21
	Calexico	300 adults	Apr. 2
Australian Saltbush (Atriplex semibaccata)[1]	2 miles west Wasco	12 adults	Dec. 14
Lowland Purslane (Sesuvium sessile)	Dixieland	7 adults	Mar. 13
Creosote Bush (Larrea divaricata)	Victorville (desert) 2–4 miles from beet fields	14 adults	Jan. 30
Red Stem Filaree (Erodium cicutarium)	King City near beet field	3 adults	May 27
	King City, foothills	3 nymphs	Nov. 28
	Bitterwater, base of foothills	100 adults	Oct. 13
	Foothills, 13 miles southwest	12 adults	Dec. 10
	Tracy	18 nymphs	Dec. 24
		25 adults	Dec. 24

Nonvirulent adults reared from eggs and kept on Black Mustard (*Brassica nigra*) failed to transmit curly leaf to sugar beets when allowed to feed previously on Creosote Bush (*Larrea divaricata*) obtained from the Mojave Desert and Imperial Valley. A nonvirulent leafhopper caused curly leaf of a sugar beet when allowed to feed pre-

[1] Plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs.

viously on the Lowland Purslane collected at Niland but two nonvirulent specimens failed to produce the beet disease from the Lowland Purslane taken at Dixieland.

Bur Clover (*Medicago hispida*) showed curly leaf symptoms caused by about 300 beet leafhoppers collected on Filaree, Bur Clover and Grass at the base of a foothill at Bitterwater on October 13. The three leaflets were folded along the sinuous distortions of the mid-rib and the transparent venation was evident on the youngest leaves. The hoppers were confined in a cage enclosing Bur Clover and the insects did not feed previously on curly leaf beets in the laboratory. After the curly leaf symptoms appeared on Bur Clover, some of the bugs were transferred to a sugar beet which also later became blighted.

The leafhoppers which hatched from eggs deposited in certain plants collected in the cultivated area of the Imperial, San Joaquin, Sacramento and Salinas Valleys sometimes caused curly leaf of sugar beets. The weeds usually became dry in the cages in a week or two and the nymphs probably were forced to feed on the beets in the later stages of their life history. Table III, gives a list of plants from which the hoppers were bred and transmitted curly leaf to sugar beets.

TABLE III—PLANTS FROM WHICH BEET LEAFHOPPER WAS BRED AND TRANSMITTED CURLY LEAF TO SUGAR BEETS

Name of plant	Locality plants collected	Date plants collected 1918	Date adults were bred 1918
Atriplex rosea[1]	3 miles south Manteca	Sept. 16	Oct. 22
Fog Weed[1]	Manteca, beet field	Sept. 5	Oct. 22
(Atriplex expansa)			
Atriplex bracteosa[1]	11 miles east Los Banos	July 14	Aug. 16
	Coalinga	July 16	Aug. 13
	Manteca, beet field	Sept. 5	Oct. 22
Russian Thistle[1]	Chowchilla	July 14	Aug. 16
(Salsola kali var. tenuifolia)	Oro Loma	July 15	Aug. 15
	Manteca, beet field	Sept. 5	Oct. 22
Rough Pigweed	Manteca, beet field	July 11	Aug. 15
(Amaranthus retroflexus)	King City, beet field	July 31	Oct. 2
	Hamilton City, beet field	Aug. 22	Oct. 19
Tumble Weed	King City, beet field	July 4	Aug. 5
(Amaranthus græcizans)	Le Grand, beet field	July 13	Aug. 16
Amaranthus deflexus	Manteca, beet field	Sept. 5	Oct. 22
Lowland Purslane	Niland	Apr. 7	June 3
(Sesuvium sessile)			
Charlock	Hamilton City, beet field	Aug. 22	Oct. 5
(Brassica arvensis)			
Black Nightshade	King City, beet field	July 4	Aug. 5
(Solanum nigrum var. douglasii)			

If nonvirulent beet leafhoppers are not able to produce curly leaf *directly* or *indirectly* by the action of a secretion poured from their mouth-parts into the beet plant, it may be possible that a cycle of

[1] Plants of the Saltbush Family (Chenopodiaceæ) to which the sugar beet belongs.

plants harbor the disease; on the one hand, the table beets, mangel wurzel or stock beets, sugar beets, swiss chard or sea kale beets and the weeds listed in Table III, growing in the cultivated territory and on the other hand, Red Stem Filaree and possibly Bur Clover in the natural breeding area. Those adults that fed on blighted varieties of beets and weeds which harbor the disease in the cultivated districts transmitted the disease to Filaree after their return flight to the natural breeding area and those nymphs which have already hatched from eggs deposited in this Filaree became virulent. After the invasion of the pale green adults of the spring brood into the cultivated sections the disease is again transmitted to different varieties of beets and such weeds as can harbor the disease. The disease would then be carried over during late spring, summer and early autumn (April to October) in plants growing in the cultivated regions and in late autumn, winter and early spring (November to April) in plants growing on the plains and foothills.

VII. Life History

A brief account of the life history of *E. tenella* under Berkeley conditions will be given. The egg period was determined during each month from February to September and varied from 16–38 days under field conditions. In one experiment dark adults obtained from King City were kept in a cage over winter at Berkeley. The first nymphs hatched on April 15. The first adult was bred on May 15, requiring 30 days to complete the nymphal instars. Twenty-two adults were reared between May 15–June 27. On September 10, the nymphs of the second brood began to hatch, the adults having died previous to this date. The first and only adult of the second brood was found in the cage on October 21.

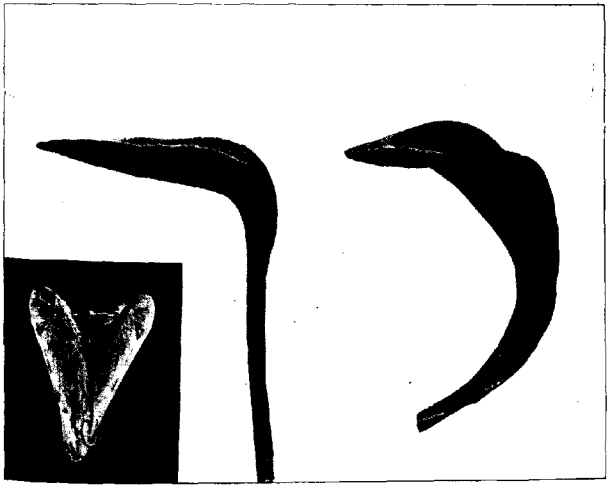
In another experiment 12 adults of the first generation were reared on June 17–July 4, from eggs deposited on March 14. The adults of the second brood were bred on November 5–15.

An interesting observation worthy of mention, is the fact that of several thousand beet leafhoppers which were reared out-of-doors at Berkeley, not a single pale green or cream colored adult was bred, every specimen without exception being dark.

Dark and Light Colored Adults

The first dark beet leafhoppers of the winter brood were captured in a beet field at Manteca on September 1. When the dark forms first make their appearance in the cultivated regions it is often difficult to detect dark males but in the natural breeding area these are easily identified during the winter. Dark females can be determined with

Sugar beet leaves in which Eutettex tenella deposited its eggs. The tissue was killed by the ovipositor and in the further growth of the plants the leaves become bent. (Original.)



Sugar beet leaves showing the above bent leaves; in insert a pair of leaf hoppers, mating, enlarged. (Original.)

certainty under both cultivated and natural conditions during the autumn and winter.

During September the dark adults gradually increased from 7–44 per cent. Before the return flight to the natural breeding area 86–98 per cent of the beet leafhoppers were dark and in December 90–98 per cent of the stragglers which remained behind in the cultivated regions were dark. In the natural breeding area 92–100 per cent of the leafhoppers were dark from October to December.

Do the yellowish beet leafhoppers assume the dark shades during autumn or winter? On September 5, 150 cream colored adults were captured in a beet field at Manteca, and were placed in a cage enclosing a sugar-beet under field conditions at Berkeley. The hoppers were transferred to a new beet on November 8, and it was found that 75 had died. On December 19, the insects were again transferred and only 6 light forms survived and these were still alive in January. Evidently most of the light forms were near the end of their natural life and only a small percentage wintered over, possibly only those of the preceding generation which reached the adult stage late.

Do the nymphs in late summer, autumn and winter give rise to light adults? On September 5, 200 nymphs were captured in a beet field at Manteca and were placed in a cage enclosing a sugar beet under field conditions, and a similar experiment was conducted at Berkeley. The adults reared were all dark. In November and December nymphs were collected on the foothills and all of the adults bred were dark.

Incomplete Hibernation

E. tenella does not undergo a complete hibernation in the San Joaquin Valley, understanding by that term the passing of the winter in a torpid state without food. The bugs are torpid during cold weather, but when the sun warms the foothills during the winter, they become active. On cold days the hoppers were rarely captured in an insect-net; such specimens as were caught, sometimes displayed a torpid condition and could be rolled about in a net without showing a trace of life. When the leafhoppers were not taken by sweeping with a net, the adults were often collected by moving the hand among the Filaree, and the disturbance would sometimes cause them to make short leaps.

Experiments were conducted to determine whether the leafhoppers require food during the winter. The hoppers were captured on the foothills and were placed in cages without food. To prevent seeds from germinating within the cages, a hole was dug in the soil and filled with about six inches of moist sand. In one cage stones and blocks of wood were placed to shelter the insects from rains. The results obtained during November and December are indicated in Table IV:

TABLE IV—NUMBER OF DAYS BEET LEAFHOPPER LIVED WITHOUT FOOD DURING WINTER

Date E. tenella began fast	Number of E. tenella	Date last E. tenella died	Number of days fasted	Mean maximum temperature	Mean minimum temperature	Precipitation
Nov. 22	60 adults	Dec. 1	9	57.6	36.7	1.06
Dec. 11	30 nymphs	Dec. 19	8	50.9	32.7	
Dec. 11	50 adults	Jan. 7	27	53.2	28.9	.46
Dec. 11	50 adults	Jan. 9	29	53.5	26.6	.53

ACKNOWLEDGEMENTS

The writer is deeply indebted to Mr. W. J. Hartung, agriculturist of the Spreckels Sugar Company, for data furnished and credited to him in this paper, and numerous courtesies extended during the work. Mr. W. W. Thomas, plant pathologist of the same company, accompanied the writer on most of the trips until he was called into the United States Army on August 7. The writer is under special obligations to Mr. S. P. Parish and to various members of the botanical department of the University of California for the determination of the plants mentioned in this paper.

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BIOLOGICAL NOTES ON THE FLATHEADED APPLE TREE BORER (CHRYSOBOTHRIS FEMORATA FAB.) AND THE PACIFIC FLATHEADED APPLE TREE BORER (CHRYSOBOTHRIS MALI HORN)

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Practically every article written in America on apple insects or even general fruit insects mentions *Chrysobothris femorata* as an injurious enemy of the apple and other fruit and shade trees. Very few, however, ever mention *mali* which according to our records is far more common and injurious in the Pacific states than *femorata*. Numerous rearings have given us *femorata* from the prune and plum a few times and *mali* from the currant, apple, plum, prune, cherry, peach and

apricot a number of times. *Mali* is also more common in shade trees and brush forests while *femorata* is commoner in the oaks and the aspen forests of the high Sierras. *Femorata* occurs throughout the United States and *mali* has been reported from Oregon, California, Nevada, Utah, Colorado and Arizona. Many of the published records of damage by *femorata* in the Rocky Mountains and Pacific states undoubtedly refer to damage by *mali*.

Both species often cause severe damage to shade trees as the following western records will show. In 1912 the writer found a number of lombardy poplar trees in the High School grounds at Yreka, California, severely injured by the larval mines of *femorata*. In 1915 Mr. Josef Brunner reported the same species destructive to small black cottonwood at Missoula, Montana. The next year Mr. W. D. Edmonston found about half of the silver maple shade trees, planted in 1913 in Colorado Springs, killed by this species and Mr. F. C. Bishoff reported serious injury to planted sycamores at Dallas, Texas. An examination of a nursery near San Jose, California, in July, 1918, showed that out of a block of 1,500 European sycamores, 2–2½ inches in diameter, 258 were already dead from an attack by *mali*, many more were infested and partially girdled and numerous others were being infested by the young larvæ. A row of 47 white flowering horse chestnuts had 4 trees killed and 17 rendered unsaleable and some young beech were in the same condition. About the same time a forty acre field of red currants near Haywards, California, was found so badly infested by this same species that the owner expected to root up the entire lot and burn them. Planted maple, mountain ash, flowering cherry, loquat, beech and birch in and around Los Gatos and San Jose are heavily infested and many trees are killed outright. Both species attack and kill the eucalyptus and appear to be becoming destructive especially in the large planted groves.

Femorata and *mali* resemble each other closely in habits, seasonal history and character of work. The first evidences of an attack are wet spots on the bark. Later, in some plants as the cherry, plum and prune there is a strong flow of gum. In all cases the bark is apt to crack and show the frass filled mines beneath.

The eggs are flattened, oval, light colored, ribbed, about 1mm. (1/25 in.) in diameter. They are laid singly, sometimes close together, on the bark during June and July. Some are laid directly on the exposed surface of the bark but most are flattened down into depressions, tucked into crevices or inserted under loose flakes or between the scales. In hatching the young larva bores through the bottom of the shell directly into the bark. It soon mines down to the wood and winds back and forth through the outer wood and inner bark

until full grown, when it forms the pupal cell in the outer wood or middle bark. Full grown larvæ of *femorata* are about ¾ of an inch long, those of *mali* about ½ inch. Feeding larvæ of *femorata* have been found under the bark from July 7 to June 10, prepupal larvæ in the pupal cells from August 22 to June 10; feeding larvæ of *mali* from July 19 to May 21 and prepupal larvæ from August 24 to July 19. The observations indicate that in California the most of both species pass the winter as prepupal larvæ in the cells. Some will pass two winters in this stage. *Femorata* has been taken a number of times in pupal cells in the bark but *mali* has always been in the wood. In the writers opinion the only reason for this is that *mali* seldom occurs where the bark is thick enough to form a pupal cell. *Femorata* pupæ were found from January 15 to September 10, *mali* pupæ from March 27 to June 19. The pupal stage lasts from two weeks to two months depending on the climatic conditions. The transformation to the beetle takes place in the pupal cell. Young *femorata* beetles have been found in the cells from March 28 to August 9, *mali* beetles from April 16 to August 7. The beetles usually pass from one to several weeks in the cells. They then emerge by an oval exit hole through the bark and are found crawling or resting on the leaves or bark of the host plant or flying about in the warm sunshine.

Femorata beetles have been taken in the field from May 15 to August 11, *mali* beetles from April 24 to August 7.

In the beetle stage the two species are easily told apart. The prosternum of *femorata* is straight across in front; that of *mali* has a short lobe. The anterior tibiæ of the *femorata* male has a number of small teeth on their inner margins, those of *muli* are abruptly dilated at the apical fourth. The larvæ are more difficult and it is a question if they can be distinguished in all cases. As a usual thing the *femorata* prepupal larvæ are larger than those of *mali*, the V on the dorsal plate of the first thoracic segment extends entirely through the rugosa area, the ventral groove is broader and deeper and the rugosities themselves are rounder, larger and more distinct.

Besides the typical *mali* there is another form which runs to *mali* in Horn's table. This may be the variety *lineatipennis*, Van Dyke. If so it should be raised to specific standing. It lives in the chaparral broom (*Baccharis pilularis*) in California and *B. sergiloides* in Arizona and does not occur in the same hosts with *mali*.

The recorded food plants of *femorata* include apple, quince, pear, peach, plum, apricot, cherry, currant and pecan among the orchard trees and oak, mountain ash, maple, beech, box elder, hickory, chestnut, sycamore, horse chestnut, linden, willow and redbud among the shade and forest trees. The records in the Branch of Forest Insect

Investigations give the black walnut (*Juglans nigra*), hickory (*Hicoria* sp.), chestnut (*Castanea dentata*), white oak (*Quercus alba*), chestnut oak (*Q. prinus*), hackberry (*Celtis occidentalis*), sweet gum (*Liquidambar styraciflua*), peach (*Prunus persica*), Texas redbud (*Cercis reniformis*) and maple (*Acer* sp.). In the west we have reared it from the smooth leafed willow (*Salix lævigata*), arroyo willow (*S. lasiolepis*), aspen (*Populus tremuloides*), black cottonwood (*P. trichocarpa*), Fremont cottonwood (*P. fremontii*), lombardy poplar (*P. nigra-italica*), white alder (*Alnus rhombifolia*), California white or valley oak (*Quercus lobata*), gambel oak (*Q. gambelii*), California live oak (*Q. agrifolia*), interior live oak (*Q. wislizeni*), California black oak (*Q. californica*), wild plum, (*Prunus americana*), domestic plum, prune (*P. domestica*), peach (*P. persica*), silver maple (*Acer saccharinum*) and blue gum (*Eucalyptus globulus*) and have taken larvæ which appear to be this species from the Carolina poplar (*P. deltoides*) European white birch (*Betula alba*) and blue oak (*P. douglassii*).

The recorded food plants of *mali* are the apple and the currant. We have reared the adults from the arroyo willow (*S. lasiolepis*), copper beech (*Fagus sylvatica purpurea*), California live oak (*Quercus agrifolia*), American elm (*Ulmus americana*), camperdown elm (*U. scabra pendula*), huntingdon elm (*U. scabra huntingdoni*), European sycamore (*Platanus orientalis*), California sycamore (*P. racemosa*), cultivated currant (*Ribes rubrum*), cultivated rose (*Rosa* sp.), mountain mahogany (*Cercocarpus parvifolius*), apple (*Pyrus malus*), European mountain ash (*Sorbus aucuparia*), Christmas berry (*Heteromeles arbutifolia*), plum, prune (*Prunus domestica*), Pacific plum (*P. subcordata*), Japanese weeping rose flowering cherry (*P. pendula*), cherry (*P. avium*), hollyleaf cherry (*P. ilicifolia*), peach (*P. persica*), apricot (*P. armeniaca*), loquat (*Eriobotraya japonica*), pea chaparral (*Pickeringia montana*), sycamore maple (*Acer pseudo-platanus*), silver maple (*A. saccharinum*), red maple (*A. rubrum*), Oregon maple (*A. macrophyllum,*) box elder (*A. negundo*), European horse chestnut (*Aesculus hippocastanam*), coffee berry (*Rhamnus california*), wild lilac (*Ceanothus sorediatus*), blue gum (*Eucalyptus globulus*) and madrone (*Arbutus menziesii*) and have taken larvæ which appear to be this species from the smooth leaf willow (*Salix lævigata*), weeping willow (*S. babylonica*), lombardy poplar (*Populus nigra-italica*), white alder (*Alnus rhombifolia*), California black oak (*Quercus california*), indian plum or oso berry (*Osmaronia cerasiformis*), evergreen buckthorn (*Rhamnus crocea*) and manzanita (*Arctostaphylos tomentosa*).

As both of these insects are produced in numbers from a great variety of native and introduced food plants practical control is rather difficult. Trees and shrubs should be well cultivated and kept in as

vigorous a condition as possible. This will not prevent an attack but it will help the plant to overcome it. Most attacks in California and the southwest start from what appears to be sunburns. Most of the smaller fruit and shade trees are attacked on the trunk. Weeping trees are attacked on the topmost branches which the leaves do not cover. Any kind of a protection which will keep the sun from reaching the exposed bark is good. Once the plant is infested, as is indicated by the wet spots on the bark, the best thing to do is to carefully cut away the dead bark, kill the borer and cover the wound with a good dressing such as coal tar or liquid asphalt.

LAC-PRODUCING INSECTS IN THE UNITED STATES (HEMIPTERA; COCCIDÆ)

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Lac (better known as "shellac") is an insect product. It is formed as a secretion from the dermal glands of certain species of Coccidæ belonging to the genus *Tachardia*. Species of this genus occur in Asia, Africa, Australia and North and South America, but at the present time only certain species found in Asia are utilized commercially. Lac is a very important article of commerce, being used as a basis for varnishes, as an insulating material in the electrical industry and for other minor purposes.

In view of the conditions existing during the late war it seemed that the possibility of developing a domestic source of supply of this substance should not be neglected. While it was fully realized that this possibility was remote, there were some grounds for believing that it existed.

We have three or four species of the genus *Tachardia* in the southwestern part of the United States. One of these species, *Tachardia larreæ* (Comstock), occurs in sufficient abundance to have attracted a considerable amount of attention and it has several times been suggested that the commercial recovery of the lac might be possible. Some encouragement has been lent to this belief by the fact that the host of this species is one of the most abundant and most widely distributed shrubs of the so-called "desert regions" of the United States. This plant is the "creosote bush," formerly known as *Larrea mexicana*, now called *Covillea glutinosa*.

Some of the reasons for believing that the matter was worthy of investigation may briefly be summarized.

Before the insect in question had received a scientific name, Dr. J. M. Stillman, later head of the Department of Chemistry of Stanford

University, had investigated it to some extent and had published several short articles concerning it. In one of these papers[1] he records the results of an examination of the lac and states: "It will thus be seen how closely the gum lac from Arizona agrees in characteristic properties, structure and chemical composition with the India varieties." In the same paper he states: "From observations by a number of gentlemen acquainted with that portion of the country, it appears that the Larrea lac is very widely distributed throughout Arizona and the southern part of California (Mohave and Colorado deserts), and the gum is used by the inhabitants in place of solder for mending kettles."

Professor J. H. Comstock[2] states: "Another true lac insect occurs in Arizona upon the stems and branches of *Larrea mexicana*. Judging from the specimens in the Museum of this department, the lac occurs upon this plant in sufficient quantity to be of economic importance."

In 1889 C. V. Riley[3] reports that a correspondent residing at Tucson, Arizona, wrote as follows concerning this lac: "I am led to believe that these exudations, if properly examined, would give a splendid bright red coloring matter and a very superior varnish resembling the celebrated Japan Lacquer. . . . I should think that a man could gather from 60 to 100 pounds of clear exudation matter in a working day of ten hours."

In 1897, Dr. L. O. Howard wrote[4]: "We have, however, in the southwest, on the very abundant creosote bush, a lac insect occurring in enormous quantity, the commercial possibilities of which have not been developed."

As there appeared to be no record that any thorough investigation of this matter had ever been made the writer called the attention of the Committee on Agriculture, Botany and Zoölogy of the National Research Council to it. This committee considered it a fit subject for an investigation and agreed to supply the relatively small sum necessary to permit the writer to carry this out.

I may state, without further delay, that the results of this investigation were entirely unfavorable. However, the information obtained should be recorded.

The first thing to be determined was the distribution and abundance of the insect. Taking into consideration the nature of the country in which the creosote bush occurs, it seemed that the investigation might

[1] Stillman, J. M. American Chemical Journal, vol. 2, p. 4 (1880).

[2] Comstock, J. H. *In* Report United States Commissioner of Agriculture, p. 291 (1880).

[3] Riley, C. V. Insect Life, vol. 1, p. 345 (1889).

[4] Howard, L. O. Bull. 9, n. s., U. S. Dept. Agric., Div. Ent., p. 38 (1897).

most easily be conducted by traveling in an automobile. This belief was entirely justified. The creosote bush area was traversed twice, from California to New Mexico, and it is improbable that any very considerable area in which the scale insect might be found was overlooked. The adventures of an almost totally inexperienced driver in piloting an antiquated specimen of our most popular type of automobile over some hundreds of miles of desert roads that in large part consist of but a pair of wheel tracks through the brush were interesting in themselves but are not properly a part of this recital and may be left to the imagination.

Owing to the conspicuous appearance of the insect, its discovery, when it is present in any significant numbers, is a simple matter. Fairly accurate observations can in fact be made from a moving car. The lac occurs as a more or less solid incrustation on the twigs of the host plant, which is a very open shrub. The insects are extraordinarily gregarious and are almost never found singly, the colonies being from a quarter of an inch to a foot long. It appears that ordinarily the "crawlers" merely move out toward the tip of the twig, thus increasing the length of the colony.

The lac evidently remains upon the branches for a year and probably much longer for dead bushes were observed to which it was still clinging. Because of this it would seem reasonable to assume that occasionally plants would be found entirely covered by the insect. As a matter of fact nothing of the sort was ever seen, even in those localities where the insect is most abundant. In no case was a bush observed to have been killed by the scale and in but a few cases were more than two or three of the entire total of many feet of branches on a bush infested. It is this occurrence in closely massed colonies that causes an entirely fictitious appearance of abundance in museum specimens. Five inches of heavily incrusted twig in a bottle will call up pleasing visions of acres of bush thus infested—but this may have been the site of the only colony in an acre of creosote bush.

The insect was not encountered in New Mexico and I am informed by Professor Cockerell, who is more familiar with the scale insect fauna of New Mexico than is any one else, that he has never seen it there. Elsewhere it was found throughout the entire area traversed. It was first encountered near Palm Springs, California, and was present constantly along the road from Mecca to Glythe, thence to Yuma and from Yuma to Tucson by way of Ajo. It was not seen east of Tuscon but in returning it was encountered again at Rice, Arizona, and then from Phoenix to Parker it was relatively abundant. It was also present along the road from Parker to Needles and from Needles

to Barstow. The last specimens were seen at Inyokern, near the southern end of the Owens Valley in California.

In all of this area the present center of abundance is in the region bordering the Colorado River in the vicinity of Blythe and Parker. Here, from the standpoint of a collector, the insect is extraordinarily abundant. I estimated that from 10 to 20 per cent of the bushes were infested and the individual infestations were heavier than elsewhere. All other points I estimated that probably not more than 2 or 3 per cent of the bushes were infested at all.

Here, then, should be the points at which the commercial recovery of the lac should be possible, if it is possible at all. Attempts to gather a large quantity of the substance for experimental purposes soon showed the futility of any such hope. I seriously question that one could gather fifty pounds of well infested twigs in a day. Of this probably not more than a pound, if as much, would be lac. And lac *retails* at 75 cents a pound.

It is further to be noted that the area in which the insect is at present most abundant is quite limited, being confined to a narrow belt on each side of the Colorado River. Even were the insect sufficiently abundant in this region to make its gathering profitable the area thus favored is entirely too small to yield any very large supply.

Whether the insect could be artificially propagated is another question. To answer it would involve a long series of costly experiments that in all probability would likewise yield negative results.

INSECT PROBLEMS OF WESTERN SHADE TREES

By FRANK B. HERBERT, *Scientific Assistant*,[1] *Los Gatos, Cal.*

A forest insect laboratory was established at Los Gatos, California, in the fall of 1916, with Mr. H. E. Burke in charge, the object being to study the insect problems of shade trees and ornamental shrubs, with general instructions from the Washington office to first get acquainted with the local shade tree problems and then the larger problems of the Pacific Coast.

In this work and region a somewhat different class of insects is encountered from those found in the forest and most of them require very different methods of control. There are, of course, some wood and bark-borers which do considerable damage to shade trees, but by far the majority of the pests are scale insects.

[1] Branch of Forest Entomology, Bureau of Entomology, U. S. Department of Agriculture.

The host plants of importance here are quite different from those encountered in the forest. The pines and firs have been mostly replaced by a great variety of broad leaved deciduous and evergreen trees, some of which are natives, while the majority are gathered from various parts of the globe. With this importation of shade and ornamental trees have come some of our worst shade tree as well as fruit tree pests.

Probably a greater variety of insects is encountered on shade trees than on any other class of trees or plants. Many of the pests of deciduous fruits, nut, olive and citrus trees, berry vines, nurseries and greenhouses are met with, besides a large array which are peculiar to forest and shade trees only.

The harboring of pests on shade trees, which are also common to different kinds of fruit trees, causes an important relation between the two. This is particularly true in southern California, where a number of towns have spread out into the citrus districts, taking shade trees with them, and on many large estates the beautiful homes are surrounded by a wealth of trees and shrubs, which in turn are surrounded by citrus orchards. Fumigation and spraying are practiced in the orchards for the control of scale insects, but not to any large extent upon the shade trees, thus leaving a bountiful supply for reinfestation.

The Argentine ant is probably the main factor in transporting the scale insects from one tree to another, as well as protecting them from their parasites, and thus becoming a pest to be contended with in the control of shade tree pests. The ant is also a pest from another standpoint in that it thrives and multiplies upon the honeydew from scale insects infesting shade trees, and from here makes detested inroads into the pantries of nearby houses. This is a problem to be reckoned with especially during these days of food conservation.

Artificial control of insects on shade trees is greatly neglected. Most farmers now realize that such control is necessary for the maintenance of healthy fruit trees and the production of clean fruit. A great many people, however, believe that a shade tree should always be able to take care of itself. Therefore, one of the problems is to educate the people into seeing that spraying is necessary at times to maintain a healthy and vigorous shade tree.

If trees and shrubbery were placed farther apart, and if each individual tree were thinned out in the top a bit, not the way the tops are often slashed by telephone linemen, but by proper cutting, thus letting in the sunshine, much of the need of spraying would be obviated. This has been demonstrated in Pasadena. There the pepper trees were badly infested with black scale until they were systematically opened up to the sun, whereupon very little spraying became necessary and that only about the lower part of some of the trees.

Many shade trees become so large that the question of spraying is not an easy one. A high power spraying apparatus of good capacity has been found practicable for such trees, but this is not always available. Fumigation is often the most satisfactory method of controlling certain pests, but again, due to the large size of many trees and the lack of apparatus in all localities outside of the citrus districts, this becomes almost impossible.

There is not a great deal known here about the proper sprays to use upon conifers and evergreens. What such trees will stand in summer or winter is not very definitely known. This is one of the problems we are working on and hope to solve.

Washing trees off with a solid stream of water is known to be one of the best remedies for removing many soft bodied scale insects. This is the most feasible means for controlling the European elm scale, particularly on large elms wherever a good pressure of water is available. At least fifty pounds pressure is necessary to give the water enough force to remove the insects. Even with this pressure one needs a travelling platform and an eight or ten foot extension rod in order to get close enough to the scale insects to remove them. With a number of large trees and plenty of available water, it is advisable to use a fire engine and hose if possible, thus obtaining a large head of water under a pressure of 125 pounds or more, which is sufficient to reach all parts of the tree from the ground. One hundred and ninety large trees in San Jose were washed in this way with good success which was more economical than any spraying would have been.

Some people would rather let a shade tree die than to lift a finger to save it from its enemies, placing more value upon the tree for firewood than for any other purpose, while others would pay a great price to save a single tree, realizing that it would take many years to replace it. Thus the question of economy of control does not always enter into a problem.

The writer has specialized to some extent upon the scale insects infesting shade trees. Below are enumerated some of the more important of them.

The European elm scale, *Gossyparia spuria* (Linn.), mentioned above, is one of our worst pests, occurring in many localities of the west and becoming a disagreeable and harmful pest, causing the trees to become black and sticky, killing limbs and sometimes whole trees. Much of the honeydew falls on the ground, making the streets and sidewalks disagreeable and dangerous to passing horses.

The cypress bark scale, *Ehrhornia cupressi* (Ehrhorn), is a serious pest in central California upon some of our most popular shade trees.

The Monterey, Guadalupe, and Arizona cypresses and incense cedar are attacked, while the Italian and Oriental cypresses are immune. This is such a pest that it is even recommended that other trees be planted instead of these cypresses in badly infested regions.

The black scale, *Saissetia oleæ* (Bern.), is a pest of shade trees as well as fruit trees. In the interior regions it apparently does little harm, but in the San Francisco Bay Region it is a particularly harmful pest on oleanders and in southern California on pepper trees. It also infests a great many other native and foreign plants.

The mealy-bugs are quite a problem by themselves. The citrus mealy-bug, *Pseudococcus citri* (Risso), is almost entirely a southern California pest, as is also the long-tailed mealy-bug, *P. longispinus* (Targ.). In the rest of California these are mostly greenhouse pests. *P. maritimus* (Ehrh.) (*bakeri* Essig) is quite a cosmopolitan pest, occurring in a great many parts of the state and on a variety of host plants, including a number of shade trees.

P. gahani Green (*citrophilus* Clausen), known as a citrus pest of Southern California, is also a shade tree pest occurring on a number of trees. It has spread rather recently to central California, the writer having found it on black locust at Burlingame, and on Pittosporum, olive, fig, Poinsettia and rose at Oakland, California. It has also been previously reported from Niles, California.

The golden mealy-bug, *P. aurilanatus* (Mask.), is a very harmful pest upon Araucarias and Agathis in Southern California. *Araucaria bidwilli* seems to suffer the worst, with *A. excelsa* next and *A. imbricata* third. Many appear black and dilapidated, while numerous dead or dying trees are reported to have been removed.

The sycamore scale, *Stomacoccus platani* Ferris, although a newly described scale insect, apparently is quite widespread, infesting both the native sycamore and the European plane tree. The writer has already located it at Los Gatos, San Jose, Evergreen, Livermore, Fresno, Claremont and Pasadena, California. It was noticed doing considerable damage in several of these localities.

Some of the other important shade tree scale insects are: the Monterey pine scale, *Physokermes insignicola* (Craw.), which infests Monterey and other pines; *Toumeyella* sp., which infests the Austrian and Monterey pines; the California pine leaf scale, *Aspidiotus pini* Comstock (*californicus* Coleman), infesting most of the common pines; the cottony cushion scale, *Icerya purchasi* Mask., which does particular damage to boxwood and acacias; the rose scale, *Aulacaspis rosae* (Bouche), collecting in great numbers on the stems of roses, where it is quite conspicuous, occasionally doing some damage; the Italian pear scale, *Epidiaspis piricola* (Del Guercio), which does considerable

damage, particularly to the native toyon or Christmas berry; the San Jose scale, *Aspidiotus perniciosus* Comstock, and *Lecanium corni* Bouche which infest a number of trees, often doing damage.

Scale insects are by no means the only pests of shade trees. Indeed there are quite a number of other pests which are of prime importance, among which may be enumerated: the California oak worm, *Phryganidia californica* Pack., which spasmodically defoliates the oaks throughout the coast region of California; another defoliater, an oak worm looper, *Therina somniaria* Hulst., which is destructive to oak foliage in Oregon and farther north; the cypress bark-beetles, *Phloeosinus cupressi* Hopk. and *P. cristatus* Lec. which kill quite a number of cypresses yearly; the oak twig girdler, *Agrilus angelicus* Horn, which kills many oak twigs, sometimes injuring trees beyond recovery; the carpenter worm, *Prionoxystus robiniae* Peck, which injures oaks, elms and cottonwoods by honey-combing the bark and wood, the flat-headed borers, *Chrysobothris femorata*. Fab. and *C. mali* Horn, which destroy the cambium of a great variety of shade as well as fruit trees; a bark-beetle in oaks, *Pityophthorus pubipennis* Lec., and three in pines, *Dendroctonus valens* Lec., *Ips radiatae* Hopk. and *Ips plastographus* Lec. which at times are quite destructive.

Many other insects might be mentioned but these will serve to indicate our more important shade tree problems. Within the next few years it is hoped that we may be able to add considerably to the knowledge of western shade tree pests.

THE VALUE OF MOLASSES AND SYRUPS IN POISONED BAITS FOR GRASSHOPPERS AND CUTWORMS

By A. W. Morrill, *Phoenix, Ariz.*

During the summer of 1917, experiments were conducted with grasshopper baits which tended to show that molasses as an ingredient was unnecessary when used against the differential grasshopper (*Melanoplus differentialis*). A continuation of these experiments with grasshopper baits during 1918 and experiments with poisoned baits against cutworms has increased the evidence against molasses for the species of grasshoppers and cutworms under observation.

History of Poisoned Baits with Reference to Molasses

The experiments referred to have lead to an examination of the literature on the subject of grasshoppers and cutworm baits in order to determine the origin of the use of molasses in connection with such baits. Apparently the first published reference to poisoned bran

bait for grasshoppers is found in Bulletin 25 of the Division of Entomology published in 1891.[1] In this bulletin C. V. Riley quotes a letter from D. W. Coquillet concerning experiments with bran-arsenate mash in the San Joaquin Valley, California, in 1885. The formula which was used in California consisted of bran, arsenic, sugar and water. Coquillet emphatically stated that the use of sugar in the poisoned mash was not for the purpose of increasing the attractiveness to the grasshoppers but merely for the purpose of causing the arsenic to adhere to the flakes of bran.

The use of a poisoned bran bait against cutworms was apparently not discovered until 1894. The first published reference to such a bait for cutworms seems to be found in a paper by J. B. Smith read before the American Association of Economic Entomologists in August, 1894.[2] The combination used consisted of bran, Paris green and water which is said to have given absolute protection to sweet potato plants which were being severely attacked by cutworms. The first use of this habit is credited to a sweet potato grower named Oliver Parry, of Beverley, New Jersey. The addition of molasses or sugar to the plain poisoned bran mixture was recommended subsequently by J. B. Smith, the object being indicated as not for the purpose of increasing the attractiveness of the bait but for the purpose of making the particles of bran adhere together and better retain moisture.[3]

No doubt molasses was substituted for sugar to suit the convenience of the users of poisoned baits against grasshoppers in California during the late eighties, but the first published reference to such substitution appears to be one found in Insect Life.[4] Mr. H. B. Jackson, a correspondent of the Division of Entomology, living in Colorado, writing under date of August 15, 1892, referred to the successful use in Colorado against grasshoppers of a bait consisting of 100 parts of bran, 3 parts of Paris green "and some old molasses or other cheap sweet substance to make it stick together." In the same issue of Insect Life, Prof. Lawrence Bruner mentions bran and arsenic used in Colorado as a poisoned bait against grasshoppers, the absence of any mention of other ingredients indicating that the use of either sugar or molasses was not generally recognized as necessary.

In 1896 an important discovery was made by onion growers in New York state as reported by F. A. Sirrine in a bulletin of the New York

[1] Pp. 59–60.

[2] Insect Life, Vol. 7, No. 2, p. 191.

[3] Catalog Insects of New Jersey, p. 21, 1900. Bul. N. J. 169, Agr. Exp. Sta., pp. 11–12, 1903.

[4] Vol. 6, pp. 32–33.

Agricultural Experiment Station.[1] In work against the dark-sided cutworm (*Euxoa messoria*) it was found that dry bran and Paris green were as attractive to the cutworms as was moistened bran and remained effective over a longer period.

In recent years the recommendations of Sirrine seemed to have been largely overlooked by economic entomologists and it has become the rule to recommend the addition of molasses in poisoned baits for cutworms. Exceptions to this rule are noted however. Dr. S. A. Forbes, for instance, writing on corn pests in 1905,[2] following Sirrine's recommendations advised distributing with a seed drill dry bran or middlings poisoned by mixing in Paris green. Other writers have recommended salt instead of sugar or molasses. Dr. James Fletcher in 1901 quoted Mr. Norman Criddle[3] in regard to grasshopper baits, recommending one part of Paris green, one part of salt and 11 parts of bran.

The literature in regard to grasshopper and cutworm baits includes very little data which bears directly upon the value of molasses as an ingredient of such baits. Messrs. Hunter and Claassen in 1913[4] experimented with various poisoned mixtures including a series of bran and Paris green with and without syrups. Their results showed practically no difference between the plain bran and Paris green mixture and the bran-syrup Paris green mixture, a total of 329 hoppers being recorded at the first and 312 hoppers at the second. Prof. G. A. Dean, referring to experiments also conducted in Kansas in 1913 and previously,[5] stated in effect that glucose syrup was preferred over molasses.

In Canada, Mr. E. H. Strickland, after experiments with poisoned baits against two species of cutworms, the red-backed cutworm and the pale western cutworm, reported without presenting data that "true beet molasses gave the best results."[6]

A Russian Entomologist, B. Pukhov,[7] in his work against extensive grasshopper outbreaks in Russia (*Gomphocerus sibiricus* and other northern species of grasshoppers) found that wet bran in itself was very attractive to the insects but that "stale molasses" decreased its attractiveness.

The writer's experiments in 1917 were given in detail in a paper read

[1] Bul. 120, p. 194.

[2] Twenty-third Rep. State Ent. of Ill., p. 18, 1905.

[3] Rep. of Entomologist and Botanist in Ann. Rep. Exp. Farm for year 1900, pp. 206-207.

[4] Jour. Econ. Ent., Vol. 7, No. 1, p. 81.

[5] Jour. Econ. Ent., Vol. 7, No. 1, p. 82.

[6] Circ. 6, Ent. Branch Dept. Agr., Dom. Can., 1916.

[7] Agric. Gazette, Petrograd, 1917. See Rev. App. Ent., Vol. V, p. 355.

before the Association and published in 1918.[1] Working with the differential grasshopper no appreciable difference was observed between a series of baits with molasses and a similar series of baits without molasses, 2,115 of the insects being recorded at the first and 2,104 at the second series. Considering the baits in which citrus fruits were used the records seemed to show a decided decrease in the attractiveness in the bait when molasses (black strap) was included.

Messrs. J. J. Davis and C. F. Turner of the U. S. Department of Agriculture experimenting with the army worm (*Cirphis unipuncta*) secured practically 100 per cent efficiency from the use of bran and Paris green with water as needed. In another series of experiments conducted in a greenhouse which the authors considered as indicating "certain possibilities which should be tested in the fields" it was found that "there seems to be no noticeable difference in baits where molasses was used and where it was left out."[2]

Mr. D. A. Ricker has recently published records on the attractiveness of baits to three species of grasshoppers, *Melanoplus femur-rubrum*, *M. atlantis* and *M. bivittatus*. By combining his records to show the apparent effect of including molasses as an ingredient we find that in five combinations in which molasses was used 176 grasshoppers were recorded at the baits while in five corresponding combinations in which molasses was omitted 236 grasshoppers were recorded.

Information from Questionnaire

The responses to a questionnaire recently sent to the heads of state entomological departments showed that in the majority of states the Kansas formula for poisoned baits is recommended against both grasshoppers and cutworms. In a number of instances the fruit is not included in recommendations for baits against cutworms. The responses in only nine instances contain information directly relating to the matter of the value of molasses as an ingredient in poisoned baits. In some instances the greater efficiency claimed for baits including molasses or baits made with one kind of sweetening agent as compared with another was stated to be a general impression or at least not supported by definite experiments.

Mr. L. B. Smith, entomologist of the Virginia Truck Experiment Station, reported poor results against cutworms by omitting the molasses from baits when used for the protection of cauliflower, tomatoes, kohlrabi and peppers while no difference was observed on account of the omission of molasses in baits used for the protection of

[1] Jour. Econ. Ent., Vol. 11, No. 2, pp. 181–182, 1918.

[2] Can. Ent., Vol. L, No. 6, pp. 187–192, 1918.

cabbage, egg plants and beans. The species of cutworms under observation were *Agostis ypsilon*, *Peridroma saucia*, *Noctua clandestina*, *Feltia subgothica* and *Laphygma frugiperda*.

Prof. G. A. Dean, of Kansas, reported that unsatisfactory results believed to be due to the omission of molasses or syrup had been noted particularly in work against the variegated cutworm (*Peridroma margaritosa*) "at a time when so abundant as to take on the habits of the army worm." He also reported having observed no difference in results against grasshoppers with baits containing black strap molasses as compared with other grades of molasses or syrups. Professor Dean's results referred particularly to *Melanoplus differentialis*, *M. bivittatus* and *Peridroma margaritosa*.

Prof. M. H. Swenk, of Nebraska, reported the general impression that baits without sweetening were not as effective against grasshoppers as baits including sweetening. Karo or glucose syrups were considered as not as efficient as sorghum or cattle molasses, the last being preferred. This report from Nebraska referred to various species of *Melanoplus*, particularly *M. femur-rubrum* and *M. atlantis*.

Prof. R. A. Cooley, of Montana, reported black strap molasses in his experience as "much better than mild molasses or corn syrup." He had not, however, tested poisoned baits for grasshoppers or cutworms omitting sweetening agents of all kinds. His department recommends the use of molasses in cutworm bait at the rate of 1 pint to 25 pounds of bran whereas the Kansas formula, requiring four times as much molasses in proportion to the bran, is recommended against grasshoppers.

Prof. C. R. Jones, of Colorado, reported having used various grades of syrups and molasses without having noted any difference in results.

Observations in 1918 and 1919

In 1918, in experiments conducted on a large scale by the writer or under his direction in Arizona, six experiments gave results relating to the use of molasses as grasshopper bait (*M. differentialis*) and one relating to its use as a bait for cutworms (*Feltia annexa*). In four experiments in which molasses was omitted in one or more tests the results were as good as when molasses (black strap) was included. In one experiment in which the molasses was increased two-thirds over the usually recommended amount no effect could be detected. In one series in which a medium light grade of cooking molasses was used instead of the usually recommended darker grade, the results were almost perfect, tending to show independent of all other experiments, that a darker grade, particularly "black strap" is not necessary.

In the fall of 1918 a bait consisting of bran, Paris green and water

distributed broadcast in the same manner as baits are distributed for grasshoppers was tested against a common alfalfa pest, the granulated cutworm (*Feltia annexa* Tr.). The mixture consisted of one-half sack (32½ pounds) of bran, one pound of Paris green and water to give proper consistency for broadcasting. This was used at the rate of eight pounds (dry bran) to the acre. A hard rain fell during the night following the application of the first batch but a few days later in the portion of the field treated with this batch as well as in parts of the field where the applications were not followed by rain no live cutworms were found as a result of a search by the writer and two other observers with a total time of about 30 minutes. In a nearby field where no poison had been applied the cutworms remained in destructive numbers, no dead specimens being found.

Early in May of the present year a severe outbreak of variegated cutworms (*Lycophotia* (*Peridroma*) *saucia* Hbn.) occurred in alfalfa fields near Gilbert, Arizona. In one instance an eighty acre field was severely damaged, in fact all growth was prevented until the cause was discovered and the remedy applied. Poisoned bran mash made according to the formula used against the granulated cutworm a few months previous, was used by Dr. O. C. Bartlett, assistant state entomologist, with results which showed practically 100 per cent efficiency. Apparently only those worms which had ceased feeding in preparation for pupating escaped the effects of the poison.

Conclusions

At the present time it may be considered as established that molasses or syrup of any kind is absolutely unnecessary as an ingredient of poisoned baits against many of the common cutworms. On the other hand some investigators have found that the addition of molasses increases the attractiveness of the bait to some species under certain conditions. Evidence is accummulating to the effect that against some species of grasshoppers the use of molasses or syrup is an unnecessary expense. Owing to the differences reported from different sections it would not be safe to assume that the same ingredients will be found equally attractive to the same species of grasshoppers in different localities. Neverthless it would seem logical to accept the results of experiments with any one species in any locality until such time as similarly conclusive experiments in other localities have proven a variabilty in results. Whenever molasses or syrup can be omitted there is not only a material saving in the cost of the bait but the simplification of the directions for its preparation leads to the more ready adoption of control measures by the farmers. While the value

of the several ingredients in baits for use against grasshoppers is still a matter for investigation it seems most logical for entomologists to recommend the simple bran and Paris green or bran-Paris green and water mixture against cutworms except when there is some definite reason for the addition of molasses, syrups or other ingredients.

EFFECT OF EXCESSIVE STERILIZATION MEASURES ON THE GERMINATION OF SEEDS

By E. R. DE ONG

Reports of fumigation injury to the germinating power of seeds are frequently based on a single piece of work with insufficient data as to the details. The injury may have resulted from improper dosage, too long an exposure, improper ventilation after fumigating, or the conditions for germination may have been so poor as to cause a distinct lowering of the percentage and this loss is then attributed to fumigation rather than to its true cause. A small number of experiments, no matter how accurate, can never be considered as giving a correct estimate of the work. Only by a large series of trials, if possible running up into the hundreds and, still better, thousands, can a correct average be obtained of the real effect on germination either from fumigating or sterilizing processes. In an effort to secure results of this type, a series of over fifty kinds of grains, legumes and nuts were treated under very severe conditions, either the dosage, time exposure or degree of heat being much greater than the maximum known to be effective. The seeds were then tested for germinating power and the nuts for impairment of flavor. The varieties tested included a number of common grains, beans and nuts so that it served the double purpose of being a varietal test and also one of sufficient numbers so as to give a fairly accurate average for the entire experiment. Each variety was subjected to exactly the same process, as samples of the entire series of grain, beans and nuts were in the oven or fumigatorium at the same time, while the entire bulk was not so large as to hinder a uniform distribution of either gas or heat. An average of about 75 seeds to the variety was used for each experiment. The varieties tested were as follows:

Wheat—Little Club, Baart, Australian White, Sonora.

Corn—Yellow Dent, Evergreen, Early Minnesota, White Dent, Honey Sorghum, Feterita, King Philip Flint.

Barley—Coast, Chevalier.

Oats—Black.

Rye—Unknown variety.

Rice (Paddy)—Sue Hiro, Wateribune.
Peanuts—Big Jumbo.
Alfalfa—Unknown variety.
Peas—Alaska Garden, Partridge.
Beans—Large Horse Bean, Small Horse Bean, Lady Washington, Bayo, White Tepary, Red Kidney, Red Mexican, Cranberry, Henderson Bush Lima, Garbanzo, Black Eyes, Pink.
Almonds—Ne plus ultra, Harriott, Texas, King, Reams, Klondyke, Drake, Big White Flat, Llewellyn, Nonpareil, California, Languedoc, IXL, Peerless.

All of these 58 varieties being subjected to eight different series, made a total of 464 experiments.

The effect on the germinating power of all the grains and vetches was very similar, so small in fact as to be almost negligible. No decided varietal difference was noted on any of the seeds tested or in the quality of the nuts. The almonds showed a slight impairment of flavor when exposed to high temperatures or for long periods to the action of either carbon disulphid or cyanide. A short exposure to either of these chemicals, even at a strong concentration or an eight hour exposure to a temperature of 125° F. all left them in apparently a normal condition.

The most striking variation was seen in beans, hence the report is shown in full for only this one group and for only seven of the eight series. The eighth series was at a similar temperature to number one, but for a shorter time, the results of the two being so alike as not to be worth repeating. This table then is a summary of seventy-seven experiments in which is seen a range in germination from 22 per cent to 100 per cent, and yet the average for the whole group is only 5 per cent less than that of the check, and small as was this loss in the beans, the variation for the grains was even less.

Beans are commonly reported to be especially liable to injury from fumigation, yet when the excessive dosages or temperatures that were used are considered it is seen that in most instances no injury whatever occurred and even these discrepancies may be and probably are, partly due to improper germinating conditions, for the greater variations come in temperature tests and are not in proportion to the degree of heat used. Every effort was made to have optimum germinating conditions, the work being done in a fairly constant temperature and all tests discarded that seemed to fail in any way.

Considering the table as a whole it would seem that beans are not so susceptible to this form of injury as is usually thought, providing the work has been carefully done and on cured stocks, these experiments being on dry beans. Isolated instances may be selected from the table which would give the impression that these treatments are dangerous. Just as occasionally we have reports of fumigation injury, but as a

whole it shows that fumigation and heat sterilization are safe practices both for grains and legumes at the dosages commonly used and with proper precautions as to the length of exposure and ventilation afterwards.

GERMINATION PERCENTAGE OF BEANS AFTER TREATMENT WITH EXCESSIVE DOSAGE

Variety	Heat	Heat	Heat	Cyanide 4 oz. to 100 cu. ft.	Cyanide 2 oz. to 100 cu. ft.	CS_2 40 lbs. per 1,000 cu. ft.	CS_2 30 lbs. per 1,000 cu. ft.	Aver.	Ck.
	Temp. 100-158° F. Time 5 hrs.	Temp.[1] 124-154° F. 2 hrs.	Temp. 125° F. 8 hrs.	18 hrs.	5 hrs.	18 hrs.	42 hrs.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Large Horse	97	94	88	100	98	96	73	91	100
Lady Washington	96	98	98	85	97	100	96	96	99
Bayo	96	100	96	95	100	96	100	97	100
White Tepary	100	39	98	97	88	95	98	88	89
Red Kidney	97	89	98	100	100	98	100	99	98
Red Mexican	68	99	100	100	100	100	98	95	99
Cranberry	81	97	90	100	97	97	100	95	99
Henderson Bush Lima	22	96	96	87	100	93	80	79	94
Garbanzo	96	65	76	75	100	72	100	83	94
Blackeye	94	94	95	97	72	96	93	91	93
Pink	100	96	99	90	100	100	100	98	99
Series averages	86	88	94	93	96	95	95	92	97
Excess in time or strength used above	10x at this Temp.	6x at this Temp.	1.6x at this Temp.	8x strength 18x time	4x strength 5x time	8x strength	6x strength 2x time		

[1] Temp. readings for series 2 are as follows: 10.45 a. m., 102° F., 1.30, 136° F., 3.45, 154° C.

ON THE ABSENCE OF INSECT PESTS IN CERTAIN LOCALITIES AND ON CERTAIN PLANTS[1]

By T. D. A. COCKERELL, *University of Colorado*

The reports of entomologists describe the ravages of insect pests where they occur, but are usually silent concerning the *absense* of infestation. In these days, when we are so greatly concerned to increase the available food-supply, it seems particularly important to ascertain where crops can be grown with the least danger from insect attack. My wife and I, having a "war-garden" in Boulder, Colorado, in 1918, gained some experience which may be worth relating. Our beans (*Phaseolus*) were completely overrun by *Epilachna corrupta*. It was thought that assiduous hand picking early in the season would abate the plague. It doubtless helped, and we got a good many beans; but the beetles came flying to the patch every

[1] This paper should have appeared with those read by title at the Baltimore meeting.—ED.

day, and eventually the plants were ruined. Experiments made at the Colorado Agricultural College not yet published, indicate that kerosene emulsion may be used with success against this insect, but it is impossible to get it applied uniformly over a town full of little bean-patches in back yards. It seems practically impossible to prevent numerous persons from raising enough bean-beetles to replenish the neighborhood. Now this *Epilachna*, for reasons not clearly understood, is of very restricted distribution. It abounds in the vicinity of the mountains, from northern Colorado to southern New Mexico. A short distance out on the plains it apparently ceases to be a serious pest. It eats only *Phaseolus*, so far as I can find; soy beans and other beans of different genera are untouched. It probably feeds on no wild plant in the vicinity of Boulder. By entirely omitting the cultivation of beans for a year or more, it could presumably be starved out, and subsequently beans could be grown with safety. In the immediate future, however, it is obviously indicated that beans should be grown in those localities where the *Epilachna* is absent or a very minor pest, and that in the *Epilachna* area the ground should be given to other crops.

Our experience with tomatoes has been very different. We got an early variety from Burbank, and the crop of the three varieties grown has been enormous. The season has been favorable, and up to the date of writing (October 11) the crop has been continuous, owing to the absence of frost. There have been no significant insect pests. Toward the end of summer, as we had observed for many years past, *Heliothis obsoleta* is very abundant in Boulder. I have observed it as early as July 27. I had thoughtlessly assumed that all these moths were of local origin, but it is now evident that they migrate from the south. Our tomatoes have been entirely free from the attacks of the larvæ, and our corn has been practically free, showing only light and negligible infestation toward the end of the season.

The tomato is not only edible as such, raw and cooked, but it may be made the basis of excellent jam. Mrs. Cockerell finds that it is possible to reduce the usual amount of sugar in the jam to a fourth, replacing the rest by commercial syrup. By increasing the acreage of tomatoes, in the region where these are not seriously injured by insects, it is possible to produce a great amount of food, much of which may be put up in the form of jam and preserves. It would, therefore, seem to be a very important function of the Entomologists to ascertain and designate the regions where tomatoes may thus be grown to the greatest advantage. It may mean the addition of hundreds of tons of food to our supplies in a single season. As with tomatoes, so with other crops. The everbearing strawberry has been a delightful sur-

prise to us in Boulder. As I write there stands before me a basket of strawberries, gathered today (October 11) by a neighbor. This plant, also, seems to have no important pests in this locality; or at any rate, it produces abundantly without any special treatment. We are probably in an optimum region for strawberries as well as tomatoes.

The girasole or Jerusalem artichoke (*Helianthus tuberosus*), of which we have a large experimental plot, is practically immune from insect or fungus attack, at least with us. Early in the season the young plants were attacked by cutworms, and it seemed that there would be some loss. But one shoot cut off, another came from a different "eye," and I believe that ultimately I did not lose a single plant.

Asparagus has been free from pests in our garden until recent years. The European asparagus beetle has now arrived and is very abundant. We have taken out most of the asparagus and replaced it by strawberries.

At this time of year it would be possible by sending out circular letters in sufficient numbers, to ascertain the optimum regions for different crops, taking into account insect and fungus attacks, soil and climate. Maps could be prepared showing these areas, with shading to indicate the minor variations. In this way, so far as one-season crops are concerned, it is possible that if the results were sufficiently widely advertised, a notable increase in production would result.

SOME RECENTLY RECORDED PARASITES OF THE ORIENTAL PEACH MOTH

By Louis A. Stearns, *Associate Entomologist, Virginia State Crop Pest Commission*

While making a preliminary canvass during the summer months of 1918, to determine the exact status of the Oriental Peach Moth (*Laspeyresia molesta* Busck) in Virginia, and to collect desirable data concerning the injury resulting from the feeding habits of this pest,[1] an accompanying study of its life history was carried on at the north Virginia field laboratory, Leesburg. Of more than six hundred larvæ collected from injured peach twigs and fruits in nearby infested orchards at different dates from mid-July until late September, and placed in vials for daily observations as to development, a large number were parasitized. During the latter part of this period, parasitism of larvæ and pupæ continued at an average of 35 per cent. Numbers

[1] "The Oriental Fruit Moth In Virginia"—Quarterly Bulletin, Va. State Crop Pest Commission, April, 1919.

of mature larvæ, which have ceased feeding in fruit, have been found to cocoon for hibernation as early as the 12th of September. The direct result of extensive parasitic attacks at this time of the year is, obviously, a material decrease in the size of the overwintering brood upon whose numbers the severity of spring twig infestation by this insect is indirectly dependent.

Eleven species of parasites were reared, seven of which have not been recorded previously as attacking the peach moth. A tachinid, *Euzenillia variabilis* Coquillett (det. C. T. Greene, U. S. Bureau of Entomology), the only dipterous parasite secured, had probably attacked the larva of its host prior to cocooning, and had then pupated within its partially constructed cocoon. During the latter part of the season, *Macrocentrus* sp. appeared in sufficient numbers to give it first rank in the records of hymenopterous parasites reared. According to Mr. R. A. Cushman, U. S. Bureau of Entomology, to whom the writer is indebted for determinations unless otherwise noted, this species, which parasitizes the codling moth (*C. pomonella*) as well, attacks the larva of the peach moth. While the larva feeds, the parasite develops, finally spinning its cocoon within that of its host. A number of specimens of *Dibrachys boucheanus* (Ratzeburg) (det. A. B. Gahan, U. S. Bureau of Entomology), the only secondary parasite reared, were taken from cocoons of *Macrocentrus* within which they had pupated. Of the remaining hymenopterous parasites, five—*Rhogas platypterigis* Ashm., *Habrobracon gelechiæ* Ashm., *Eubadizon gracilis* Prov., *Goniozus* sp. (det. S. A. Rohwer, U. S. Bureau of Entomology), and *Leucodesmia nigriventris* Girault (det. J. C. Crawford, U. S. Bureau of Entomology)—attack *L. molesta* in the larva stage; and three—*Itoplectis conquisitor* (Say), *Pimplidea æquallis* (Prov.), and *Phægenes* (*Centeterus*) sp. (det. A. B. Gahan, U. S. Bureau of Entomology)—attack *L. molesta* in the prepupa or pupa stages.

Experiments with various sprays, including those commonly recommended for the suppression of insect enemies of peach and the other deciduous fruits which this pest attacks, have been variable in their results—mostly unsatisfactory. The rôle played by these minute dipterous and hymenopterous forms in the control of this recently established insect cannot, therefore, be too highly valued at the present time.

THE STRENGTH OF NICOTINE SOLUTIONS

By V. I. SAFRO, *Louisville, Ky.*

The terms designating the strength of nicotine solutions are very often used quite loosely and in some cases erroneously. Too often, for instance, we see mentioned "40 per cent nicotine sulphate" when the intent is to specify "40 per cent nicotine *as* sulphate"—far from being an equivalent statement. It is highly desirable, then, that the factors that constitute the strength of nicotine solutions be well known and that certain old erroneous ideas be definitely disposed of. In order to bring this matter to the attention of entomologists, these nontechnical remarks are submitted.

When properly used as a spray, nicotine solutions are practically independent of sunlight, humidity, or any other atmospheric conditions for their effectiveness as contact insecticides, the problem in the field being concerned solely with wetting the insects thoroughly with a solution of the required nicotine strength. (The practice of using a greater nicotine strength is sometimes followed in order to make up for carelessness and lack of thoroughness on the part of the grower, or for the lack of spreading properties of the spray caused by using hard water without the addition of a sufficient softener and spreader.)

ODOR NO INDICATION OF COMPARATIVE STRENGTH.—Many growers make a practice of endeavoring to ascertain the comparative nicotine strength by the odor of the preparation. This has been a common practice among greenhouse men. As a matter of fact, the characteristic odor of tobacco is not due to nicotine. It is due to a great extent to the essential oils of the tobacco plant and to other extractive material with which we are at the present time not very well acquainted.

The writer has before him the following preparations:

100% Nicotine
43% Nicotine } Uncombined; *i. e.* "free"
3% Nicotine
40% Nicotine as sulphate.
Tobacco oil (no nicotine)

An attempt to obtain the comparative nicotine value of these preparations by odor is impossible. The preparation that contains the strongest tobacco odor is the preparation of tobacco oil which contains no nicotine whatever. On the other hand, the preparation containing 100 per cent "free" nicotine possesses very little odor and that differing quite materially from the tobacco oil. In fact, the odor present in the sample of 100 per cent "free" nicotine has no similarity to the characteristic tobacco odor. The preparation containing 3 per cent

nicotine has a stronger odor than either the preparation containing the 43 per cent or the 100 per cent, the 43 per cent having very little odor indeed. The preparation of 40 per cent nicotine as sulphate has a stronger odor than the preparation of 100 per cent "free" nicotine and is again of a different character than the odor of any of the other nicotine preparations.

COLOR NO INDICATION OF COMPARATIVE STRENGTH.—We have been accustomed to believing that the higher nicotine concentration, the darker the color. The coloring matter is almost entirely due to materials other than the nicotine extracted from the tobacco plant. The preparations mentioned above in demonstrating that odor has no relation to nicotine strength may also be used to show that color is no indication of comparative nicotine content. The preparations containing 43 per cent and 100 per cent nicotine are almost the same in color—a transparent red—and both are clearer and lighter in color than the 40 per cent nicotine as sulphate and the nicotine—free tobacco oil, both of which are dark brown in color, almost opaque, and heavier than the other preparations.

PER CENT NICOTINE CONTENT ALONE INSUFFICIENT AS STATEMENT OF EXACT STRENGTH.—Most of the commercial nicotine solutions on the market contain 40 per cent nicotine *by weight*. The nicotine may be in the form of "free" nicotine or in the form of nicotine sulphate, but the per cent refers to the amount of nicotine, by weight, because it is the only method of knowing definitely how much actual nicotine is contained in the solution and such designation is required by the Federal Insecticide Board. It is necessary, then, to know the specific gravity of the preparation in order to know the actual nicotine content.

Below is a list of three commercial preparations, each containing 40 per cent nicotine by weight, showing the variations that exist in several preparations.

Preparation	Sp. Gr.	Approx. Weight Per Gal.	Pounds Nicotine Per Gal.
A	1.20	10 lbs.	4 lbs.
B	1.0	8 "	3.2 "
C	.927	7.4 "	2.97 "

Dilutions, being by volume, would in the case of each of the above 40 per cent preparations give solutions of widely different nicotine content, granting that the same dilution is used with each preparation.

PER CENT NICOTINE CONTENT TOGETHER WITH SPECIFIC GRAVITY CONSTITUTES STATEMENT OF EXACT STRENGTH AND COMPARATIVE VALUE.—In order to know the definite value of a nicotine solution,

the total *weight* of nicotine in the solution should be known. In the three commercial preparations mentioned above, each preparation is labelled 40 per cent nicotine and yet in one case four pounds of nicotine and in another only 2.97 pounds of nicotine are contained in the same volume of solution.

Scientific Notes

European Elm Scale. On May 27th, the writer found an American elm on the college grounds infested with European elm scale (*Gossyparia spuria*). This, apparently, is the first time the insect has made its appearance at Ames. The college collection has a specimen from Des Moines, but we have been unable to find a published record for this state. ALBERT HARTZELL, *Ames, Iowa.*

European Corn Borer (Pyrausta nubilalis Hubn.) in New York. A recent determination by Messrs. Heinrich and Schaus, through the courtesy of Doctor L. O. Howard, of moths reared from corn stalks collected near Schenectady has positively established the occurrence of this serious pest in New York State. A subsequent identification by Mr. Heinrich of moths reared from corn boring larvæ suspected of being *Pyrausta nubilalis* has shown the Dutchess County insect to be *Pyrausta penitalis* Grote. This is welcome news and unless upset by subsequent discoveries, means that European corn borers occur in but one area in New York State and probably in but two in the United States. E. P. FELT.

Corn Borer in Connecticut not the European Species. In this JOURNAL for April, page 218, is a note to the effect that "what appears to be a small infestation of the European corn borer was found in Milford, Conn., March 12." Adults have now been reared from this material and we are pleased to announce that they have been identified by specialists at Washington as *Pyrausta penitalis* Grote, and not the European corn borer, *Pyrausta nubilalis* Hubner. W. E. BRITTON.

Swarms of Aphids. On June 23 and 24 vehicles and pedestrians passing through Chapel Street, and some other nearby thoroughfares in New Haven, Conn., were literally covered with small green insects which were flying in the air and were caught on the clothes, and tops of automobiles. One of the seed stores telephoned to my office inquiring what they were; some of their customers took them to be the arrival of the much heralded "seventeen year locust." On investigating the matter they were found to be aphids, afterwards identified by Dr. Edith M. Patch as *Calaphis betulæcolens* Fitch, a species infesting birch and supposed to remain upon that host throughout the season. Just why they migrated is a conundrum, unless because they became so abundant that they were forced to leave in search of food. Though there are a few birches in the city, there are doubtless many acres on the Orange hills, two or three miles to the southwest, from whence they came. Several observers noticed the swarms of aphids in New Haven and Hamden at this time and also the preceding week. W. E. BRITTON.

Army Entomological Laboratory. Malcolm E. MacGregor, a Carnegie student who studied in this country several years ago, informed Dr. Howard in a recent letter that he is in charge of the War Office Entomological Laboratory, Kitchener Camp, Sandwich, Kent, adding that the tropical campaigns have made the English tumble on many facts which they could not see before. The laboratory exemplifies the last word in modernity, all the apparatus being run by electricity and the equipment being beautiful in every way. Mr. MacGregor extends a most hearty welcome to any American entomologist who may be visiting in England. E. P. F.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1919

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The Albany Conference on the European Corn Borer situation should accomplish two things. It should first of all aim to give all those attending the fullest possible information respecting the insect and the condition of the infested territory. Much of the former is familiar to entomologists though there have been a number of new developments during the summer. The more salient facts concerning the status of the borer as a pest and the possibility of exterminating it should receive special consideration at the hands of all present. There will be an opportunity of examining the infested territory in both New York and Massachusetts at a time when the work may be expected to show to best advantage and this should not be neglected by any having more or less responsibility for the control of injurious insects in the corn growing sections of the United States.

The main object of the conference is to agree upon a policy which will be acceptable alike to scientists and administrators, and one that can be carried to a successful conclusion. The possible as well as the practical should receive due attention and most important of all, an effort should be made to depict clearly the ultimate results of the various policies, if there be different ones advocated. The American people are coming to rely more and more on the decisions of experts. The apparently impossible is becoming commonplace in these stirring days. This conference may mean the beginning of startling developments in insect control. It is for the entomologists of this country to anticipate the future so far as practicable and present a feasable program and then stand as a unit for its execution.

Current Notes

Conducted by the Associate Editor

Dr. A. D. Hopkins of the Bureau of Entomology visited the Ohio Station, March 30.

The University of California has conferred the doctorate of laws upon Prof. Vernon L. Kellogg of Stanford University.

Prof. H. A. Gossard of the Ohio Agricultural Experiment Station, addressed the Paper Shell Pecan Grower's Association at Chicago, March 8.

Mr. R. W. Wells of the Bureau of Entomology has been detailed to conduct work on biting flies of cattle in coöperation with the Nevada Station.

Mr. H. E. Hodgkiss, formerly of the Agricultural Experiment Station, Geneva, N. Y., is now professor of entomology extension, State College, Pa.

Mr. Quincy S. Lowry is spending the summer on corn borer work for the Massachusetts State Board of Agriculture, and at present is located in Lexington, Mass.

Mr. J. R. Stear, formerly assistant in entomology at the Ohio Agricultural Experiment Station, has accepted a position with the Pennsylvania State Department of Agriculture.

Dr. W. C. Woods is spending the summer at the Agricultural Experiment Station, Orono, Maine, studying the Chrysomelidæ. He will return to Wesleyan University, Middletown, Conn., in the fall.

According to *Science*, the honorary professional degree of master of horticulture has been conferred upon Edmund H. Gibson of the U. S. Bureau of Entomology, by the Michigan Agricultural College.

According to *Science*, two new laboratory buildings are planned for the College of Agriculture at Los Banos, Philippine Islands, one of them to house the department of entomology and plant pathology.

Dr. M. W. Blackman, Department of Forest Entomology, New York State College of Forestry, Syracuse University, is at the Agricultural Experiment Station, Orono, Maine, for the summer working upon forest insects.

Mr. Lloyd R. Watson, extension worker in apiculture in Connecticut for the past year, has been permanently transferred to the apicultural laboratory of the Bureau of Entomology at Washington, D. C., as special field agent.

According to *Science* the title of Commander of the Order of the Crown of Belgium has been conferred on Dr. W. J. Holland, director of Carnegie Institute, Pittsburgh, Pa., in recognition of the "devotion shown by him to the cause of Belgium."

According to *Science*, Lieut. Asa C. Chandler, Sanitary Corps, formerly assistant professor of zoölogy at Oregon Agricultural College, has undertaken parasitological work at the Central Medical Department Laboratory of the A. E. F. at Dijon, France.

Dr. H. H. Knight, formerly of Cornell University, was discharged from the Army in April, and has since accepted an assistant professorship in entomology at the University of Minnesota. His work will be almost wholly systematic in character.

Mr. Don C. Mote, formerly Economic Zoölogist, Ohio Agricultural Experiment Station, was appointed State Entomologist of Arizona by the Arizona Commission of Agriculture and Horticulture. He assumed the duties of the new office July 1, 1919.

A school and conference for beekeepers will be held at the University of Wisconsin College of Agriculture, Madison, Wis., August 18–23. In addition to local instructors, Dr. E. F. Phillips and Mr. G. S. Demuth of the Bureau of Entomology are on the program.

Prof. W. C. O'Kane of the New Hampshire College and Experiment Station and president of this Association is ill and has been ordered by his physician to take a complete rest. He has been obliged to drop his work probably for the remainder of the summer.

According to Entomological News, deaths of European entomologists are announced as follows: W. F. de Vismes Kane, Ireland; Sydney Webb, England; Dr. Raphael Blanchard, J. K. D'Herculais, France; Grand Duke Nicholas Michailovitch, K. Robert, Russia.

By recent act of the legislature of Pennsylvania, the Bureau of Economic Zoölogy has been eliminated, and a Bureau of Plant Industry created embracing all the duties of the old Bureau with additional ones. J. G. Sanders is Director and W. A. McCubbin Deputy Director of the new Bureau of Plant Industry.

C. L. Metcalf of Ohio State University is teaching biology in the summer session of the New York State College of Agriculture. Professor Metcalf received the degree of Doctor of Science from Harvard University in June. He will return to the Department of Zoölogy and Entomology in Ohio State University in August.

Mr. Roger C. Smith has been awarded the one-hundred dollar Walker Prize in Natural History given by the Boston Society. He submitted a paper on "The Biology of the Chrysopidæ," his doctor's thesis, which will very likely be published as a memoir of the Cornell University Agricultural Experiment Station.

Professor Herbert Osborn is spending a few weeks at the North Carolina Agricultural Experiment Station, working on Homoptera with Z. P. Metcalf. He was injured in an automobile accident, had a narrow escape, and was laid up for a month with bruises and strains, but is now able to do laboratory work and some field collecting.

According to *Science*, Dr. Frank E. Blaisdell, Sr., of Stanford University, and Mr. E. P. Van Duzee, curator of the entomological department of the California Academy of Sciences, will spend their summer vacation studying the entomological fauna of the Lake Huntington region, Fresno county, California, at an elevation of 7,000 feet.

Among the papers read before the thirty-ninth annual meeting of the Society for the Promotion of Agricultural Science at Baltimore, January 6 and 7, was the presidential address, "The Problem of the Permanent Pasture with Special Reference to Its Biological Factors," by Professor Herbert Osborn, and "Some Codling Moth Life History Studies," by C. P. Gillette and G. M. List.

Mr. George M. Codding, who for fifteen months was employed as extension entomologist in Connecticut by the Bureau of Entomology, has accepted a position with the F. A. Bartlett Co., Stamford, Conn., Tree Surgeons, Entomologists and Foresters. Mr. Codding was employed under the act to stimulate agriculture during the war and his position terminated June 30, by limitation, as the appropriation was not renewed.

Dr. Arthur H. McCray, State Bacteriologist of Montana and formerly of the Bureau of Entomology, died of spotted fever June 14, 1919. Dr. McCray was born November 14, 1880, and graduated from the Ohio State University in 1908. While

serving with the Bureau of Entomology his work was connected with bee diseases, on which several papers were published. He was graduated from the Medical department of George Washington University in 1915. He was ill eleven days before his death.

The following resignations from the Bureau of Entomology are announced: H. W. Lee, to enter business; H. H. Nininger, to become special extension entomologist for Kansas; F. H. Gates, to enter commercial work at Phoenix, Ariz.; A. P. Swallow, to become extension entomologist in truck crop insects at the Texas Agricultural College; Stewart Lockwood to enter State work, North Dakota; C. W. Creel to become State extension entomologist, Nevada; W. E. Dove; Dr. W. Dwight Pierce to enter private business.

Dr. C. L. Marlatt, assistant chief of the Federal Bureau of Entomology, and chairman of the Federal Horticultural Board, visited the Kansas State Agricultural College May 19. He gave a very instructive address to the Entomological and Zoölogical Seminary on some work of the Federal Horticultural Board. Dr. Marlatt, who is an alumnus of the Kansas State Agricultural College, was a member of the entomological staff in that institution from 1884 to 1888, at which time he resigned to enter the service of the Federal Bureau of Entomology.

According to *Science*, Mr. Charles W. Leng, secretary of the New York Entomological Society and research associate in the American Museum of Natural History, has been appointed director of the museum of the Staten Island Institute of Arts and Sciences, and began his duties June 1st. Mr. Leng has been interested in the natural history of Staten Island, where he was born and lives, since boyhood. Entomologists and other naturalists, visiting New York City, can reach the museum of the institute by a pleasant half hour's sail across the bay on the Staten Island ferry.

At a meeting of the Board of Regents of the University of Nebraska during the latter part of May, Professor Lawrence Bruner, who has been in charge of the entomological activities in Nebraska for the past thirty years, was retired from active service on part salary, owing to his continued ill health. Prof. Myron H. Swenk, who has been in active charge of the entomological work of the state for several years past, was made chairman of the Department of Entomology in the University, state entomologist of Nebraska and entomologist in the Experiment Station.

According to *Science*, Mr. J. G. Sanders, director of the Bureau of Plant Industry of the Pennsylvania Department of Agriculture, at Harrisburg, Pa., has been commissioned by the Federal Horticultural Board at Washington to study the potato wart disease in the British Isles, and to note the methods adopted for controlling the spread of this most dangerous potato diease. The potato wart disease was first determined by him to occur in the United States in a district comprising four counties in the vicinity of Hazleton, Pa., in September, 1918. These four counties, with three outlying points, are now under strict quarantine.

According to *Science*, an entomological expedition to South America is planned by Prof. J. Chester Bradley, '06, of the College of Agriculture of Cornell University. Leaving Ithaca next September, Professor Bradley will visit Brazil, Argentina, and Chile; in the following spring he will be joined in Peru by Professors Cyrus R. Crosby and Dr. W. T. M. Forbes, of the Agricultural College, and the party will work on the Amazon River as far as Peral near the headwaters. The expedition is conducted under the auspices of the university for the two-fold purpose of securing entomological specimens and of forming closer relations with South American institutions of learning.

The following transfers are announced in the Bureau of Entomology: Geo. W. Barber to corn borer work, Arlington, Mass.; L. G. Gentner from extension to investi-

gational work on truck crop insects in Wisconsin; O. D. Deputy to have charge of all border fumigation work, Texas; L. P. Rockwood in charge of field laboratory at Forest Grove, Ore., made vacant by the resignation of C. W. Creel; Mortimer W. Leonard, extension entomologist in New York state to truck crop insects and to estabish a field station on Long Island for the study of potato insects; W. A. Thomas extension entomologists in North Carolina, to truck crop insects to establish a field station in that state.

The following appointments have been made recently in the Bureau of Entomology: Harry Sargent, port inspection work, Seattle, Wash.; C. A. Bennett, entomological inspector, Washington, D. C.; Joe Milam, J. D. Smith, J. W. Hill, Clarksville, Tenn.; L. Z. Naylor, boll weevil laboratory; H. Y. Gouldman, plant quarantine inspector, Washington, D. C.; W. H. Goodwin, C. H. Hadley, plant quarantine inspectors, Riverton, N. J.; Robert Fouts, specialist in hymenoptera, U. S. National Museum, Washington, D. C.; William R. Irving, bean weevil investigations, Alhambra, Cal.; J. W. Sauer, sweet potato weevil investigations, Kingsville, Tex.; D. Arthur Perry and K. W. Babcock, temporary field assistants corn borer work; Miss Harriet L. Arnold, Tempo, Ariz; M. L. MacQueen, L. N. Judah, Scott C. Lyon, T. P. Weakley and James T. Lewis temporarily, tobacco insect investigations; W. E. Haley, temporarily, Sugar Cane Insect Laboratory, New Orleans, La.

According to *Science*, mosquitoes representative of all species occurring at camps or posts where troops of the United States are stationed are to be collected for the Army Medical Museum in Washington. At present the collection is incomplete and medical officers have been directed to see that collections of these insects are made at the times and in the manner described in circular instructions being published. Collections of mosquitoes are to be made at each station at least biweekly, at three periods during the twenty-four hours, early morning from 5 to 6 a. m., midday, and after 7 p. m. The times of collection will vary in different latitudes, but observation will determine the time when the insects are most prevalent at each locality. They are to be collected by means of a suitable killer or by mosquito traps. The "chloroform tube" is the best and most easily obtained killer, and mosquito traps are also useful. Shipments of the mosquitoes in lots of 25 each in specially prepared boxes are to be mailed by medical officers at camps to the curator, Army Medical Museum, Washington, D. C.

The Arizona State Legislature at its recent session appropriated $65,350 for the work of the state entomologist during the ensuing biennium, also $2,775 for the present fiscal year to meet a prospective deficiency arising from increased costs of operation. The new appropriation includes an increase of $21,000 over the last biennial appropriation. This increase is due in part to the increased costs and in part to the extension of the Egyptian cotton growing industry in the state, the cotton crop ranking ahead of all other crops in valuation in 1918. In addition to the appropriation bills one other bill was enacted which is of much importance to the work of the state entomologist. This amends the law creating the Arizona Commission of Agriculture and Horticulture in important particulars with reference to qualifications for membership on the commission. After June 15, 1919, each of the three members, in addition to being the owner of improved agricultural land within the state, must be engaged in fruit growing or some branch of farming as his "principal occupation and business" and he must file a sworn statement that he is fully qualified as specified by the law. The director of the Experiment Station will not be an ex-officio member of the new commission as in the past. Definite terms of office are provided with one vacancy every two years. In the event any member during his term ceases to possess any of the specified qualifications his membership automatically ends.

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